ELECTRICAL ENGINEERING

SEPTEMBER 1959
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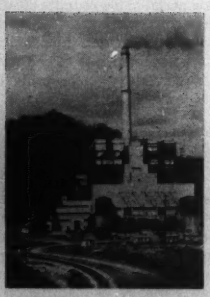
75 Years
A Prologue to the Future



THE COVER: The Clinch River Plant of the Appalachian Power Co. at Carbo, Va. Extensive use of Kaylo insulations, manufactured by Owens-Corning Fiberglas Corporation, contributes to plant efficiency by reduction of heat loss, thereby resulting in conservation of fuel. Story appears on p. 969.

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How Okonite solves your High-Voltage Distribution Problem

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These four 7500-volt Okolite-Okoprene self-supporting aerial cables span 395 feet to distribute power to a section of a Southern paper mill. Easy to install in one simple operation, Okolite-Okoprene self-supporting aerial cable reduces clearance space requirements, is neat-appearing, often may be installed on existing buildings or supports, offers greater safety to personnel and eliminates insulator flashover due to contamination. Okonite's patented Dualay assembly can be tapped hot at any point in non-shielded types.

LOXARMOR

And on any high-voltage construction, a Loxarmor covering offers economy and flexibility in a cable system where the complete protection of a rigid conduit system is not required. Excellent mechanical protection is provided by a Loxarmor interlocking "S" tape available in galvanized steel, aluminum, bronze or copper. Loxarmor saves money in installation and initial purchase costs, makes it easy to add or re-route circuits and requires less space than conduit to handle the same number of circuits.

One of these high-voltage cable constructions will fill your requirements. Write for Bulletin EG-1117, "How to Choose Insulated Cable," to The Okonite Company, Subsidiary of Kennecott Copper Corporation, Passaic, New Jersey.

***where there's electrical power . . . there's* OKONITE CABLE**

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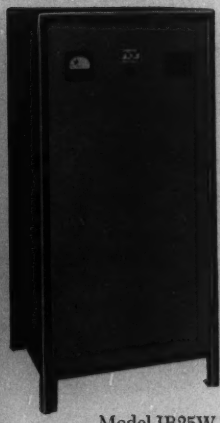

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50	IR50W	IR50X	IR50Y	
75		IR75X	IR75Y	
100		IR100X	IR100Y	IR100Z
150		IR150X	IR150Y	IR150Z
200		IR200X	IR200Y	IR200Z
300		IR300X	IR300Y	IR300Z
400		IR400X	IR400Y	IR400Z
500		IR500X	IR500Y	IR500Z

Available ac input voltage (3 phase, 60 cps)

208v	to	600v	for	25,	50,	&	75kw
440v	to	600v	for	100,	150,	&	200kw
440v	to	13,800v	for	300,	400,	&	500kw

A Salute to the American Institute of Electrical Engineers

Congratulations to the American Institute of Electrical Engineers upon its 75th Anniversary.

During the last 75 years, the electrical engineers have accomplished more in the field of electronics than in the 75 million or billion years our planet Earth has been in orbit.

A man-made machine breaking the sound barrier is not nearly so significant as breaking into the secrets of electricity and the electromagnetic bands.

Indeed, piercing the sound barrier and outer space would not have been possible without the practical application of the skill and science of the electrical engineer.

He has helped extend our voices and our eyes not only around the earth but around the planetary system with the speed of light. He has helped probe the depths of the earth and helped scan the skies for the great enrichment of man's knowledge of his physical environment.

He has helped light our homes and cities, lifted many burdens from the backs of men and women, and has started to light the dark unsolved electronic mysteries of the future.

Truly, the next 75 years will see many miraculous accomplishments, aided, in a large measure, by the hard work and knowledge of the electrical engineer. But, it is doubtful that the strides of advancement will be equal to those of the past 75 years.

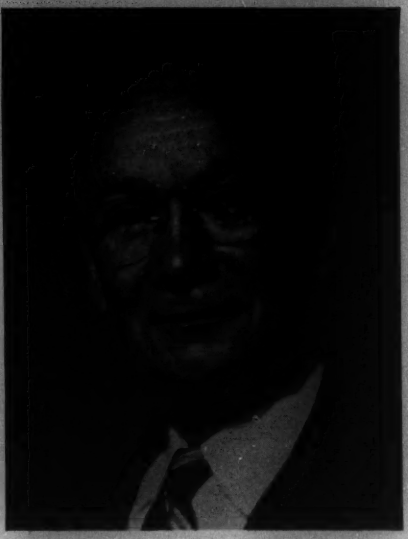
Hence, with great pride to be privileged to be alive during part of this period, I salute and congratulate you upon your 75th Anniversary.

John C. Doerfer

Chairman
Federal Communications Commission

A I E E 75th Anniversary 1884 — 1959

75 Years—
A Prologue to the Future



The Institute's 75th Year

L. F. HICKERNELL
PRESIDENT AIEE 1958-59

In the annual President's Address, various highlights of the Institute's activities during the past year are discussed.

THE AIEE CONSTITUTION, 1901 revision, required the president to deliver an address "at the Annual Convention." By 1948, with more frequent meetings scheduled, this phrase had been amended to read, "at one of the General Meetings." The word "convention" had been replaced because it had somehow acquired a connotation of revelry rather than of serious purpose.

In some respects, this address is one of the most difficult of the president's duties. Even though there are evidences of work completed, progress seems slow in one administrative year (actually a 9-month period because of summer inactivity). However, we have only to step back for an objective view to see that, while taken singly, a year's accomplishment may seem meager, taken in groups of 5, 10, or 25 years, the Institute, along with the electrical industry, is taking vigorous forward strides.

This 75th year has certainly been an eventful one, abounding with both happy and sad occasions. In counterpoint to the usual hum of AIEE's operation, congratulatory messages on our anniversary and celebrations at meetings provided high notes throughout the year.

Perhaps foremost among the harassments was the cancellation of the Fall General Meeting, which delayed the start of the year's activities for many organizational groups.

The 1958-59 Report of the Board of Directors presents complete details and statistics on the year's operations. Some of the highlights will be recounted here.

75TH ANNIVERSARY CELEBRATION

CELEBRATION of the Institute's 75th Anniversary was initiated by an address at the general session of the Pacific General Meeting, August 1958.

A publicity kit was issued to the Sections, containing a 16-page booklet entitled "75 Years—A Prologue to the Future" (the Anniversary slogan) and other material to help the Sections plan individual celebrations.

A "Salute to the American Institute of Electrical Engineers" appears in each issue of *Electrical Engineering* this calendar year. President Eisenhower's greeting appeared in January, followed by messages from Herbert Hoover, James R. Killian, Jr., Wernher von Braun, and others.

The May 1959 *Electrical Engineering* was a commemorative issue containing 22 articles by outstanding engineers and scientists, reviewing the advancements during the past 25 years and forecasting future developments within their respective fields.

On the Institute's birthday, May 13th, a Founder's Day Luncheon was held in New York City. The principal speaker, appropriately, was W. P. Marshall, president, Western Union Telegraph Company, the position held by Dr. Norvin Green when he became AIEE's first president (See *Electrical Engineering*, August 1959, pp. 808-10).

A 75th Anniversary Luncheon was held at the Summer and Pacific General Meeting at Seattle. President-Elect J. H. Foote was the speaker at this celebration.

Plans are under way in the Philadelphia Section to commemorate the 75th anniversary of the first technical meeting of the Institute, held in that city on October 7-8, 1884.

Full text of an address presented in abstract at the general session, AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Wash., June 21-26, 1959

L. F. Hickernell is vice-president–engineering, Anaconda Wire & Cable Company, Hastings on Hudson, N. Y.

HONORS FOR AIEE MEMBERS

TABLE I SHOWS the honors awarded to Institute members during the year.

Nominations are being reviewed for the first recipients of the William A. Habirshaw Award for achievement in transmission and distribution, and the Morris E. Leeds Award for accomplishment in electrical measurement.

Negotiations have been completed for two new awards honoring famous Institute members: the David Sarnoff Award for achievement in electronics, and the Mervin J. Kelly Award for distinguished contribution in the field of telecommunication.

NEW CONSTITUTION

CULMINATING 3 years of intensive effort, an entirely revised Constitution in more useful form was completed by the Constitution and Bylaws Committee, and submitted to the membership for approval on March 26, 1959.

The Board approved a policy recognizing three documents, each including only such subjects as require approval by an appropriate body. These documents, and the units which approve them are:

1. Constitution	Institute Membership
2. Bylaws	Board of Directors
3. Procedures	Departments

It was further resolved that each of these documents shall conform to all the provisions of the superior document.

EXECUTIVE COMMITTEE

FROM 1947 THROUGH 1957, the Board of Directors held five meetings each year. In 1957-58, it held four. By Resolution of October 5, 1956, the Board expressed its desire that the Departments be charged with responsibility for administering the policies established by the Board. On August 21, 1958, the Board resolved that there shall be three regular meetings of the Board each year, and that the Board's powers shall be delegated to the Executive Committee to conduct affairs of the Board between its meetings.

Accordingly, the Executive Committee held three meetings, the first of which was a telephone conference to discuss and act upon cancellation of the Fall General Meeting.

Table I. Institute Members Honored, 1958-59

Recipient	Honor Conferred
AIEE Awards:	
D. A. Quarles	Honorary Membership
Luigi Emanueli	Honorary Membership
C. F. Kettering	Edison Medal
H. S. Black	Lamme Medal
J. F. Calvert	Electrical Engineering Education Medal
E. W. Engstrom	*Prize, Best Electrical Engineering Article
Ira Richer	Fortescue Fellowship
Joint Society Awards:	
Mervin J. Kelly	John Fritz Medal
Ghaffar Farman-Farmaian	Alfred Noble Prize

*Initial Award

UNITY OF THE PROFESSION

EACH OF THE CONSTITUENT SOCIETIES of the Engineers Joint Council (EJC) was asked by the EJC president to review the work and position of the Council. In responding, AIEE recommended the Functional Plan as describing the proper sphere of activity for EJC.

In reply to the recommendation of a joint committee of EJC and Engineers' Council for Professional Development (ECPD) that the two Councils be merged, AIEE filed a report entitled "Position on Organization of the Engineering Profession" (*Electrical Engineering*, February 1959, pp. 124-27), which pointed out that "there appears little to be gained and much to be lost by merging ECPD into an organization in which the seeds of incompatibility are inherent so long as a 'professional division' is considered." Later, the AIEE Board of Directors advised that the merger would be unacceptable.

During the past year, the presidents of the five Founder Societies have held seven conferences in an attempt to evolve a unity organization which would be mutually acceptable to these Societies and the National Society of Professional Engineers. Currently under discussion is the Functional Plan with a Co-ordinating Council (*Electrical Engineering*, August 1959, pp. 832-38). Although some progress in understanding has been made, the goal is not yet in sight.

NEW UNITED ENGINEERING CENTER

AS OF JUNE 12, 1959, Institute members had pledged $757,577, or 84% of our quota of $900,000. Considering that in 1904, with a membership of approximately 3,000, AIEE members raised $150,000 toward the $200,000 necessary to purchase land and furnish the present Engineering Societies Building, we should be able to meet our share of the expenses of this new home of the Founder Societies.

Contributing to the cost of the new building is one way to work toward the unity sought by the several engineering societies. The United Engineering Center (UEC) will be a symbol of unity among engineers of America, located in an area spotlighted perhaps more than any other in the world. The United Nations, across the street from the UEC site, attracts more than a million visitors each year, apart from the delegates and staff members sent by the 82 member nations.

The UEC will not only be a source of improved service to engineering society members, but also will enhance the prestige of the engineering profession; hence, of the individual engineer as a member of that profession.

Title to the site was acquired on October 1, 1958.

Tentative working schedule for construction of the UEC is:

1. Completion of Working Drawings.....August 30, 1959
2. Confirmation of Guaranteed Cost.....September 30, 1959

Table II. Summary of Income and Expenses

	1956-57	1957-58	1958-59	Increase (Decrease) 1958-59 over 1957-58	
Income					
Dues and Fees	$ 882,016	$ 911,634	$ 947,675	$ 36,041	4.0%
Advertising	534,861	511,211	414,655	(96,556)	(18.9%)
Publications Sales	184,182	186,821	200,459	13,638	7.3%
Investment Earnings	57,845	50,872	53,288	2,416	4.7%
Registration Fees and Special Technical Conferences	38,882	73,446	38,864	(34,582)	(47.1%)
Standards Sales	20,337	23,930	19,193	(4,737)	(19.8%)
Other	919	1,962	3,788	1,826	93.1%
TOTAL	$1,719,042	$1,759,876	$1,677,922	$ (81,954)	(4.6%)
Expense					
Publications	$ 788,879	$ 826,576	$ 860,834	$ 34,258	4.1%
General and Administrative	294,672	329,108	340,899	11,791	3.6%
Districts and Sections	152,471	159,217	168,159	8,942	5.6%
General Committees	58,327	87,457	104,069	16,612	19.0%
Meetings (General and District)	62,270	68,028	77,715	9,687	14.2%
Building and Library (UET)	54,309	62,476	66,894	4,418	7.1%
Technical Committees	58,848	66,878	50,159	(16,719)	(25.0%)
Student Branches	44,347	38,654	44,473	5,819	15.0%
Other Society Activities	18,474	36,169	30,654	(5,515)	(15.3%)
TOTAL	$1,532,597	$1,674,563	$1,743,856	$ 69,293	4.1%
Excess (Deficit) of Income over Expenses	$ 186,445	$ 85,313	$ (65,934)	$ (151,247)	(177.0%)

3. Commencement of Construction ..... October 15, 1959
4. Completion of Construction ..... March 15, 1961
5. Completion of Occupants' Requirements ..... July 1, 1961

MEMBERSHIP

MEMBERSHIP on April 30, 1959, was 53,827, showing an increase slightly less than the previous year. Other comparisons with 1958 are:

	Increase (Decrease) Number	Per Cent
New Members	203	5.4
Former Members Reinstated	(165)	(41.7)
Members Lost by Death or Resignation	89	10
New Applications	311	6.7
Student Transfers	500	21.1

Up until 1952, the Institute enjoyed a 10% annual increase. To maintain this rate of growth would require approximately 8,000 new members annually, the figure being based on 5,000 net increase plus 3,000 to offset loss of members by death, resignation, or suspension. This situation needs the attention of every individual member, for services to members are practically proportional to income, half of which is from dues.

Student Membership. Student membership was 11,616, showing an increase of 1,024, or 9.7%, the largest since 1951 which was the last year of the World War II veteran surge.

FINANCES

TABLE II is a summary of income and expenses since 1956, when dues were increased $5. In two years, expenses have increased $211,259, or 13.8%, while income has decreased $41,120, or 2.4%, leaving us with a deficit of income over expenses as follows:

Year	Excess (Deficit) Income over Expense	Deficit Increase over Previous Year	Credit (Deficit) per Member
1956-57	$186,445		$3.68
1957-58	85,313	$101,132	1.63
1958-59	(65,934)	151,247	(1.23)

Income. Total income decreased $81,954, or 4.7%, during the fiscal year ended April 30, 1959. This is accounted for by the decrease in two major sources of income, as follows:

	Increase (Decrease) Amount	Per Cent
Dues and Fees	$36,041	4
Advertising	(96,556)	(18.9)
Registration Fees and Special Technical Conferences	(34,582)	(47.1)

Expenses. Total expenses increased $69,293, or 4.1%, primarily because publication expense increased $34,258, also 4.1%, and meetings expense increased $9,687, or 14.2%.

Expenses for student activities (including Branches, publications, prizes, trips to Summer General Meeting, etc.) totaled $107,710.

Table III. Summary of *Transactions* Pages Published

Part No.	Title	1957	1958	Increase	
I	Communication and Electronics	771	1,076	305	(39.6%)
II	Applications and Industry	440	704	264	(60.0%)
III	Power Apparatus and Systems	1,578	1,736	158	(10.0%)
	TOTAL	2,789	3,516	727	(26.1%)

PUBLICATIONS

PUBLICATIONS account for half our expenditures.

Table III is a summary of *Transactions* pages published in the calendar years 1957 and 1958. The 727-page increase during 1958 was attributable to a 39.6% increase in *Communication and Electronics,* and a 60% increase in *Applications and Industry* bimonthly publications.

Fig. 1 shows the number of pages published in the three bimonthly publications (and annual *Transactions*) since July and August 1952 when they were first issued. During the 7-year period, the number of pages

increased 70%. Because of this increase in pages and doubled circulation, expenses increased $155,552.

To reduce the net cost, the Board of Directors was forced to discontinue sending each member a bimonthly publication of his choice, and to impose an annual charge of $2.50. This went into effect on May 1, 1959, so the full effect of the charge, and resulting reduced

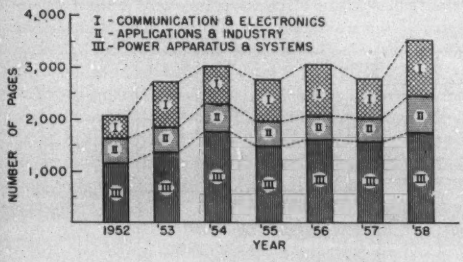


Fig. 1. *Transactions* pages published, 1952-58.

circulation, have not yet been realized. However, there is every indication that a $5 charge should have been authorized, as originally recommended by the Publications Department.

To further reduce expenses, the Publications and Technical Operations Departments have set a limit of 20 pages per paper (in preprint form), and a budget of 500 papers for publication in 1959-60.

MEETINGS AND PAPERS

COMBINED REGISTRATION at General and District Meetings and Special Technical Conferences was 45,781, an increase of 7,675, or 20.3%. The total number of papers presented was 2,633, an increase of 474, or 22%.

General and District Meetings. Registration at General Meetings decreased 1,043, or 10.3%, while the number of papers decreased 69, or 7%. The record registration of 6,545 at the Winter General Meeting failed to offset the cancellation of the Fall General Meeting.

Five District Meetings were held during the fiscal year ended April 30, 1959, as compared to four the previous year. However, because of territorial changes, some of the Districts are smaller. Registration increased 84, or 3.6%, even though the number of papers decreased by 19, or 6.6%.

Special Technical Conferences. Table IV is a summary of Special Technical Conference statistics. An increase in number of Conferences from 27 to 33 accounted for the increase in registration and papers. Registration was 34,147, an increase of 8,634 or 33.8%; total number of papers was 1,452, an increase of 562, or 63.3%.

Of 33 Conferences, 19 were jointly sponsored. Those under sole AIEE sponsorship increased from 9 to 14. Published proceedings increased from 15 to 22. Exhibits almost doubled, from 6 to 11.

SECTIONS AND BRANCHES

SINCE THE SECTIONS AND STUDENT BRANCHES are autonomous, each planning and conducting its own program, their efforts do not lend themselves to summarization.

While the number of Sections remained unchanged at 112, Subsections increased during the past year from 67 to 77, and Student Branches increased from 157 to 163.

Bylaw 46 was revised to set forth with greater formality and clarity the procedures to be followed in forming and terminating Subsections.

Educational activities in the Sections increased during the year. Study groups have been formed in several Sections, utilizing as a textbook, "Electric Power Distribution for Industrial Plants" (Publication No. 952), prepared by the Industrial Power Applications Committee, now the Industrial and Commercial Power Systems Committee. Other Sections reported having conducted series of lectures on popular topics, with excellent attendance.

Greater co-operation has been effected between Sections and Student Branches, resulting in a marked increase in the number of graduates electing to remain in AIEE.

The Sections Operation Manual and Activities Booklet are being revised and combined into one publication.

Preliminary work has been completed on a new Branch Organization Manual.

TECHNICAL ACTIVITIES

A NEW TECHNICAL ACTIVITIES COMMITTEE was organized to incubate new technology in electrical and related fields not included in scopes of present technical committees.

The Research Committee prepared a brochure entitled "An Invitation to Research," with an accompanying list of funds available for research, and distributed it to accredited engineering schools. Object is to increase new research in the universities through the Engineering Foundation.

The Safety Committee constantly seeks awareness of safety considerations, and is working toward uniform requirements of the National Electrical Code and the Canadian Electrical Code.

The Standards Committee undertook revision of the Standards Manual, a continuing project. It is striving

Table IV. Summary of Special Technical Conference Statistics

	1957-58	1958-59	Increase	
Number sponsored:				
AIEE	9	14	5	
Jointly	18	19	1	
TOTAL	27	33	6	(22.2%)
Registration	25,513	34,147	8,634	(33.8%)
Number of Papers	890	1,452	562	(63.3%)
Proceedings Published	15	22	7	(46.6%)
Exhibits Held	6	11	5	(83.4%)

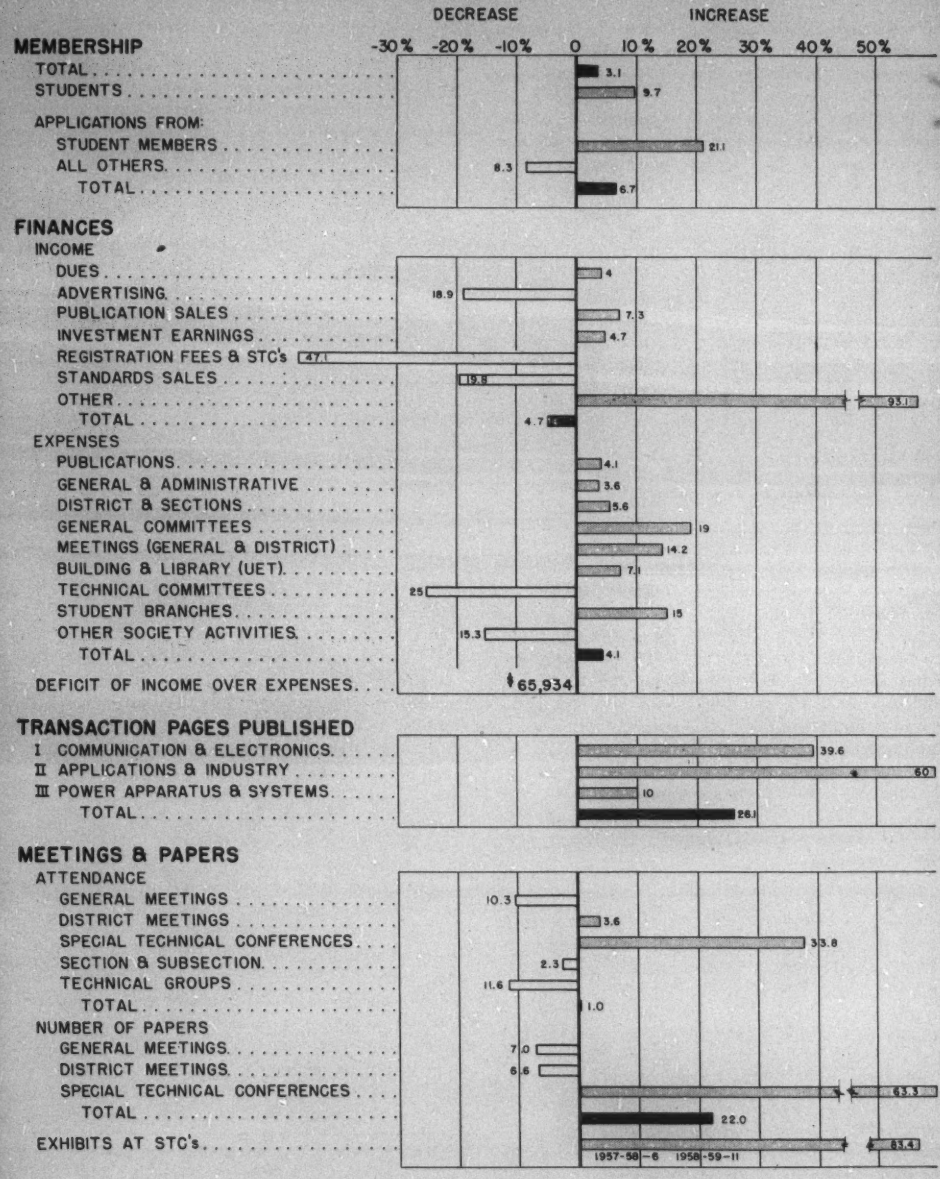


Fig. 2. Statistical summary, 1958-59.

to see that standards are developed in those areas not adequately covered, and seeking to improve the effectiveness of AIEE co-operation with the American Standards Association.

The Feedback Control Systems Committee has developed a program to publish a newsletter on an experimental basis.

At the 1959 Nuclear Congress, AIEE sponsored 5 of the 23 sessions and contributed 25 of 125 papers presented, more than any other of the 30 societies participating. This speaks well for AIEE leadership in the nuclear technical area.

The Insulated Conductors Committee is co-operating with the Insulated Power Cable Engineers Association in preparing new ampacity tables for insulated cables in several environments. The 100,000 intricate computations will be made on a digital computer. The Soil Thermal Resistivity Research Project at Princeton University was completed on August 1, 1958, and the results are being summarized for practical application.

The Magnetic Amplifiers Committee co-operated in translating an 800-page Russian book, and found no new technical information. The book covered the period 1954-56.

This brief report is by no means indicative of the total accomplishment of the technical committees during the year. By and large, the committees are concerned with discussing and seeking solutions to current problems in their respective fields. The amount of work required to solve these problems may be little or great, and constitutes a worthwhile service, although it does not lend itself to inclusion as a notable item on an abbreviated list of accomplishments.

THE 75TH YEAR IN STATISTICAL SUMMARY

FIG. 2 SHOWS, for better or worse, the upward or downward trend of every Institute operation lending itself to numeration. Percentage increases or decreases shown were obtained by comparing the 1958-59 figures with those for 1957-58. The chart discloses that the plus side of zero is more populated than the minus side.

CONCLUSION

FOR 33 YEARS NOW, I have been taking part in the Institute's technical or administrative activities. I have always given some, sometimes all, of my personal time to AIEE, and do not regret one minute of it. In the Institute, I have found a second career. Also, many of my closest friends and most admired colleagues are AIEE members whom I came to know through one or another Institute activity. Through personal experience, I can state that the Institute triply repays those who participate in its work: technically, professionally, and socially.

AIEE was formed because the need for an American society had been created by the rapidly developing art of producing and utilizing electricity. Among the men who organized and nurtured the Institute were Edison, Bell, Gray, Vail, Brush, Thomson, Houston, and Weston. The Institute was a source of pride to these men, and was their bequest to the generations of electrical engineers who were to succeed them. We cannot share their greatness, but all of us can emulate their pride in the Institute. We can strive to enhance this heritage while it is ours, before we, in turn, relinquish it to the electrical engineers of the future.

Automatically Controlled Ladle for Steel Pouring

The teeming of molten steel into ingot molds from this 85-ton capacity ladle is controlled automatically by the steel pourer, who opens and closes the ladle stopper by pushing buttons on a pendant. The site is Jones & Laughlin Steel Corporation's new basic oxygen furnace shop at Aliquippa, Pa.

At the oxygen facility, Jones & Laughlin has developed a highly efficient pouring or teeming practice, geared to almost continuous production of steel from the oxygen furnaces. These furnaces produce a heat of 81 tons of steel in about 20 minutes.

Using a Blaw-Knox Company "Autopour" attachment on the ladle, the steel pourer can fill a 5-ton capacity open-top mold in less than a minute. He stands at a safe distance from the ladle and exerts no manual effort to raise and lower the heavy stopper rod. Hydraulic power, controlled electrically, moves the rod to open and close the orifice in the bottom of the ladle.

Are Transformer Stabilizing Windings Necessary?

B. A. COGBILL
FELLOW AIEE

FOR MANY YEARS it has been common practice to include a Δ-connected stabilizing winding in Y-Y-connected transformers and Y-connected autotransformers. This applies to 3-phase units of all types of core construction as well as 3-phase banks of single-phase units. The practice has been followed so closely for such a long time that it is generally taken for granted that the stabilizing winding is a necessary part of all Y-connected transformers. In many cases it is; but it is not necessary or even desirable to include a stabilizing winding in all cases regardless of type of core construction and system characteristics.

Omission of the stabilizing winding usually has very significant and often profound effects on zero-sequence and third-harmonic characteristics and any phenomena which are influenced by these characteristics. The degree to which zero-sequence and third-harmonic characteristics are affected is largely a function of the type of magnetic circuit (core) used in the transformer construction. If the core is of the 3-legged 3-phase type the effects of omitting the stabilizing winding are not extreme. On the other hand, if any other type of core (shell-type 3-phase, 5-legged 3-phase, or 3 single-phase cores) is used, the effects are of an entirely different order of magnitude.

During the early days of 3-phase power systems, transformer connections consisted of banks of single-phase units; so when problems associated with zero-sequence and third-harmonic quantities in 3-phase systems first appeared on the scene, they were in terms of the characteristics of banks of single-phase transformers. In cases of Y-Y connections without stabilizing windings some of the problems related to:

1. Poor voltage regulation when line-to-neutral loading was not balanced. The loads on many of the early 3-phase systems were not well balanced so high zero-sequence impedance was quite undesirable.
2. Telephone interference caused by third-harmonic current in the power system transmission lines and in the ground circuit. Some 40 or 50 years ago many of the telephone circuits consisted of a single line with ground return strung near and parallel to the power lines (sometimes on the same poles); all of which resulted in conditions conducive to telephone interference.
3. Hazardous voltages produced by resonance of third-harmonic inductive reactance of the transformer bank and third-harmonic capacitive reactance of transmission lines to ground.
4. False operation of ground detecting relaying equipment caused by third-harmonic current in the ground circuit.

Quite early in the history of 3-phase power systems, it was learned that addition of Δ-connected stabilizing windings provided an over-all solution to many of these problems. So the practice of including a stabilizing winding in practically all such connections was established. When 3-phase units were introduced, the practice was carried over to them apparently without much thought having been given to whether the stabilizing winding was actually necessary regardless of type of core construction. In fact, the differences in characteristics which resulted from use of different types of cores were not fully understood or appreciated at the time. Hence, the practice of playing it safe by including a stabilizing winding in all Y-Y transformer connections became practically universal.

The various factors involved are much better understood today than they were 40 or 50 years ago. Also conditions have changed since the early days of 3-phase systems. As a result of improved technology and changed conditions, the idea that a stabilizing winding is needed in all cases is simply archaic. This fact has been recognized by some electric utility companies who have purchased and have had in operation for a number of years Y-Y-connected transformers and Y-connected autotransformers without stabilizing windings. There has been no indication that any of them has been responsible for trouble in service with respect to the power system or communication circuits.

Some conclusions reached are:

1. It is perfectly satisfactory to omit stabilizing windings from Y-connected transformers in many cases if 3-legged 3-phase core-type construction is used.
2. Omission of the stabilizing winding affects zero-sequence and third-harmonic characteristics; but fundamental frequency, positive-sequence characteristics are not affected.
3. How much zero-sequence and third-harmonic characteristics are affected depends upon the type of magnetic circuit used. On the one hand, if a 3-legged 3-phase core is used, the effects are not very great. On the other hand, if any other type of core is used, the effects of omitting the stabilizing winding are of an entirely different order of magnitude.
4. The high-reluctance, zero-sequence flux path and the presence of the transformer tank combine inherently to produce, to a very significant extent, the effects of a stabilizing winding in the case of 3-legged core-type construction. This is not true of other types of cores.

Digest of paper 58-1169, "Are Stabilizing Windings Necessary in All Wye-Connected Transformers," recommended by the AIEE Transformers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Empire District Meeting, Syracuse, N.Y., April 29-May 1, 1959. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1959.

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The Ferroresonant Circuit

G. E. KELLY, JR.
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A CIRCUIT which consists of a capacitance in series with an iron-core reactor, with or without other circuit elements, may be a ferroresonant circuit.

The circuit studied consisted of resistance and capacitance in series with an iron-core reactor, the iron-core reactor being the 120-volt winding of a 2-kva, 120/240 volt, single-phase transformer with the 240-volt winding on open circuit.

The purpose of this study is:

1. To determine whether the rms currents in the circuit and the rms voltages across the nonlinear reactor, under various values of applied sinusoidal voltage, can be satisfactorily predicted from calculations in which rms currents and voltages are treated as if they were of fundamental frequency only.
2. To predict the probability of the occurrence of each of two possible voltages across the reactor in a region where either is possible.
3. To observe subharmonic voltages across the nonlinear reactor, if present, and to record the conditions under which they occur.
4. To illustrate the application of the ferroresonant circuit to the problem of open conductors in 3-phase circuits.

Circuit Characteristics. It may be seen from Fig. 1 that there are three possible values of current for one value of applied sinusoidal voltage. In test circuits there are points of discontinuity (critical points), *x* and *y* of Fig. 1, and no test values of fundamental frequency can be obtained between these points.

Comparison of Calculated and Experimental Curves. Two methods of calculation were used, both making use of the excitation characteristics of the reactor.

In the first method, the exciting current was assumed as reference vector. In the second method, the reactor voltage was assumed as reference vector. A better check of calculated and experimental characteristics was obtained by the second method in which the apparent resistance of the reactor was included.

Probability of Occurrence. To predict the probability of the occurrence of each of two possible voltages across the reactor when either is possible, a ferroresonant circuit was set up and four types of tests were made.

Tests Results. The conclusions reached included the following:

1. Once on a high- or low-voltage path (curves *yz* and *Ox* respectively of Fig. 1) there is a change from one path to the other at points of discontinuity only.
2. The second point of discontinuity (*y* of Fig. 1) is limited by resistance in the ferroresonant circuit only.
3. There is a phase reversal at each point of discontinuity.
4. As no subharmonics were observed at any time during the tests, it is concluded that their occurrence in the particular circuits studied would be rare indeed, if at all.
5. In the region of the current-voltage characteristic of a ferroresonant circuit where there are two possible values of reactor voltage and current for one value of applied sinusoidal voltage, the values that will be obtained by opening and closing the switch is a function of (a) the initial conditions, (b) the region of the current-voltage diagram, and (c) the voltage across the reactor (high or low) before opening and then closing the switch.
6. In the immediate vicinity of the points of discontinuity the response becomes independent of the voltage across the reactor after the circuit has been closed and opened a number of times (as few as five times).

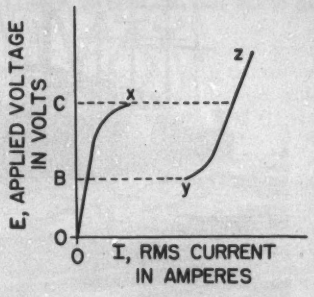

Fig. 1. Current-voltage characteristic of a ferroresonant circuit.

Comparison. Calculated and tests results show the following:

1. Calculations do not give results of sufficient accuracy when apparent resistance of iron-core reactor is neglected in calculations.
2. Calculations give an excellent check of the test rms currents and voltages across the reactor up to the first point of discontinuity and the first point of discontinuity itself when apparent resistance of iron-core reactor is included. The check is fair for the second point of discontinuity.

Digest of paper 58-1168, recommended by the AIEE Electronics Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Pittsburgh, Pa., Oct. 26-31, 1958. Published in AIEE *Communication and Electronics*, Jan. 1959, pp. 843-48.

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The Atlantic Cable

Part I

BERN DIBNER
FELLOW AIEE

In this era of shrinking distances, it may be hard to realize that slightly more than a century ago it took weeks to communicate between the European and American continents. In one giant leap, electrical technology all but annihilated time and distance, bringing both continents within a few seconds' reach of each other. This is the story of that epoch-making achievement. It introduces the contributions of some of the giants of 19th Century electrical science—Lord Kelvin, Morse, Faraday, and others. It is told in three installments.

ONE cannot seriously object to those who would arbitrarily identify the recent centuries by such handy labels as calling the 1400s, the century of Discovery (Gutenberg and Columbus); the 1500s, the Century of Exploration (Magellan and Copernicus); the 1600s, the Century of Reason (Galileo and Newton), and the 1700s the Century of Enlightenment (Diderot and Franklin). This brings us to the very threshold of the Century of Science. A true scion of such noble ancestry was Electricity.

In the very year 1800, Alessandro Volta published a paper in the *Transactions* of the Royal Society describing his invention of the Voltaic pile. This gave the increasing number of experimenters on both sides of the Atlantic a new instrument—a source of constant-flow electricity. By 1820, experimenters had devised an electric arc that shone with extraordinary brilliance, water had been decomposed into oxygen and hydrogen, and electroplating had been demonstrated. In 1820, Oersted had discovered that a magnetic field surrounded a wire carrying an electric current and thereby linked two major phenomena of Nature—electricity and magnetism—the latter an ever-present effect of the first. The invention of the electromagnet was followed by the invention of the electromagnetic telegraph demonstrated by Morse in 1837. This invention was as revolutionary as the printing press some 400 years earlier.

The electric telegraph was the first important and large-scale practical application of the new electric force. It shrank distances across continents to almost nothing, for it took no longer to transmit a message across a continent than it did across a street. The first electric telegraph line was constructed between Washington and Baltimore in 1844 and the highways of both continents were soon lined by poles and cross-arms carrying wires through which the silent electric messages streamed in ever-increasing numbers.

Professor Morse had spanned the harbor of the City of New York in 1842 by laying down an insulated copper wire through which he succeeded in sending a telegraph message. This wire was insulated by hemp soaked in tar and pitch and surrounded by a layer of india-rubber. Three years later Ezra Cornell, who afterwards founded Cornell University, connected Fort Lee with New York by an underwater line 12 miles long which stretched across the Hudson River. The telegraph line consisted of two cotton-covered copper wires, insulated by india-rubber and enclosed in a lead sheath. After several months' successful operation, the line was broken by an ice floe early in 1846.

As these lines spread out, the world's distances shrank in inverse proportion. It was inevitable that when these networks reached eastward along the Atlantic seaboard across states and provinces, over mountains and under rivers, bays and straits, the easternmost point of land would be reached. Similarly, moving westward, the networks in Europe would stand poised at the western shore of Ireland. There then remained the gap of nearly 2,000 miles of the Atlantic, a challenge to the scientist of vision and to the entrepreneur.

And so it was that the long fingers of the telegraph systems stretched eastward from Maine into New Brunswick, and then farther east to Sydney in Nova Scotia. From the easternmost point at Cape Breton, a submarine cable was laid across the Gulf of St. Lawrence's Cabot Strait to Cape Ray, the western point of Newfoundland, with St. John's on its eastern shore.

The dreamers and designers of systems of submarine telegraphy could draw on the experience of the successful submerged cable between Dover, England, and Calais, France, laid in 1851 by the brothers Brett. This cable weighed 12,000 pounds to the mile. Another cable

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"The Atlantic Cable," book, published by Burndy Library, 1959.

was laid in 1854 between Corsica and La Spezia weighing 16,000 pounds to the mile. In the following year yet another was laid from Varna to Balaklava on the Black Sea; this served for military use during the Crimean War and weighed less than 300 pounds to the mile.

In 1850, the hope of connecting Newfoundland with the American continent was expressed by J. T. Mullock, a Bishop of Newfoundland, who proposed that some private company, English or American, should undertake to link St. John's by telegraph, crossing the island and Cabot Strait, then on to Cape Breton Island and Nova Scotia.

The same suggestion came from F. N. Gisborne, an English engineer and telegraph operator who, in the winter of 1849-50, proposed a similar link to the Newfoundland legislature which granted him £500 sterling for an exploratory survey. He had had experience in the construction of telegraph lines in Nova Scotia and New Brunswick.

Gisborne's energetic efforts culminated in the first lengthy submarine cable in America, connecting Prince Edward Island to New Brunswick, laid in November 1852.

ORGANIZATION BEGINS

In constructing the line from St. John's to Cape Ray, Nfld., Gisborne found the terrain so rugged that he decided to place the line underground. He managed to cover only a distance of some 30 or 40 miles when his funds were cut off and he was sued and subsequently arrested under the pressure of his creditors. This took all his resources. In the meantime, the success of the Dover–Calais line prompted Gisborne to abandon his original plan for spanning the Gulf of St. Lawrence by ship and carrier pigeon and instead to substitute a submarine cable across Cabot Strait between Cape Ray and Cape Breton.

He left Halifax and came to New York in January 1854, to take counsel with his sources of finance. It was here that he met Matthew D. Field, a civil engineer, who had been building railroads and suspension bridges in the newly opened South and West. Field became interested in Gisborne's plans and decided to speak to his brother, Cyrus W. Field, a successful New York merchant who had retired from active business the year before. Although only 34 years old and with an ample fortune in reserve, Cyrus Field, who had just returned from a 6-month visit in the mountain areas of South America, was disinclined to begin a new and speculative enterprise. However, the challenge of a telegraph line extending through Newfoundland appealed to him and he invited Gisborne to his home. After an evening's conversation, Gisborne left, and Field moved leisurely to the globe standing in his library in order to visualize the extension of the telegraph system into this new area. It was then that the idea occurred to him that it would be of enormous advantage to continue the telegraph line across the Atlantic Ocean. Some 10 years earlier, Professor Morse had stated that "a telegraphic communication might with certainty be established across the Atlantic Ocean," and others undoubtedly expressed the same conviction, but the idea occurred afresh to Field as he projected the possibility of such a line upon the globe.

Field contacted Morse who showed an even deeper interest in the questions raised. This was the beginning of a friendship between the two men that was to continue for their lifetime.

Morse explained the basic laws of electrical flow to Field and said that he felt certain that a transatlantic cable would be practical. He referred to a letter which he had written as long ago as August 10, 1843 (11 years earlier), to John C. Spencer, then Secretary of the Treasury, which had followed a series of experiments made in New York Harbor to test the practicability of underwater telegraphy. In it he said, "The practical inference from this law is, that a telegraphic communication on the electro-magnetic plan may with certainty be established across the Atlantic Ocean! Startling as this may now seem, I am confident the time will come when this project will be realized." Following these encouraging reports from Morse and a Lt. M. F. Maury, who had taken a series of soundings of the ocean floor, Field decided that he would speak with a number of his capitalist friends to see if they would support his enterprise to span the Atlantic via Newfoundland.

Thus began one of the great sagas in modern history, touching the fields of science, politics, finance, and geography.

Field organized a syndicate of five partners who formed the "New York, Newfoundland, and London Telegraph Company." With this change in charter also came a change in mission because Gisborne's old company had intended to span the Atlantic link by ship and thus hoped to transmit a message from England to America in "only six days." It became the intent of the new company to tie the two continents together directly and *electrically*.

Field went to England in the autumn of 1854 to order the cable to span the 85-mile Cabot Strait from Cape Ray to Cape Breton. There he met John W. Brett who had successfully spanned the English Channel with two submarine telegraph lines in 1851. They were 25 nautical miles long and consisted of no. 14 copper wire, insulated with a half-inch thickness of gutta-percha, and protected by an armor of spirally wound galvanized iron wires. A means of testing the continuity of the wire at that time consisted of applying the electrician's tongue to sense the flow of current. At each shore station a coastal length of wire was installed; it consisted of a no. 10 BWG (Birmingham Wire Gauge) covered by cotton tape soaked in india-rubber solution. This was then encased in a thick lead tube.

The first attempt to lay the Newfoundland cable ended in failure when the cable ship, a sailing bark, was destroyed halfway across the Gulf of St. Lawrence by a heavy gale. The second attempt succeeded using a motor-driven cable ship. The cable, the first to employ

stranded instead of solid wire for the conductor core, functioned for 9 years.

Much more difficult was the task of spanning the island of Newfoundland by 400 miles of road and telegraph line. But this was accomplished in 1856. The company also joined the ends of the island of Cape Breton with a telegraph line 140 miles long. With these links completed, the telegraph system stretched solidly from St. John's in Newfoundland to New York, a distance of 1,000 miles.

SOME EARLY PROBLEMS

THE FULL ATTENTION of the directors of the enterprise was now turned to the problem of the Atlantic. The ocean's bottom had to be studied for the specific task of carrying a slender cable; its character had to be more carefully determined than had already been done by a series of soundings by Lt. Maury. Tests had to be undertaken to learn if the ocean bottom was jagged with sharp rocks and whether ocean tides would wear through the soundest armored cable in time; also, if the ocean bottom were cut by valleys and chasms, a cable hung across such voids would sag and part because of its weight if the gaps were too wide.

Lt. Berryman, U. S. Naval officer, and Lt. Commander Joseph Dayman, of the British Navy, in separate excursions—the former taking soundings along the great circle arc, intended as the line of the Atlantic Cable, to the coast of Ireland and the latter moving westward from Valentia, Ireland, to Newfoundland—confirmed the existence of a plateau varying in depth from 1,450 to 2,400 fathoms, gradually increasing from the shores of Newfoundland towards Ireland. This plateau had previously received the name of the "Telegraphic Plateau."

Field left New York on July 19, 1856, for Great Britain to organize the Atlantic Telegraph Company. He called on the firm of Glass, Elliot & Company of London, a firm which had begun to specialize in the manufacture of submarine cables. Their chief engineer, Samuel Canning, had acquired more experience with this type of cable than anyone else. Field also consulted Robert Stephenson and Isambard K. Brunel, son of a famous engineer and himself a builder of railroads, tunnels, and steamships. The world's largest ship, the *Great Eastern*, was then under construction and Mr. Brunel invited Mr. Field to see the monstrous hull rising on the banks of the Thames. Said Mr. Brunel, "There is the ship to lay the Atlantic Cable!" Neither of the men realized that in 10 years this would be the ship to finally and successfully accomplish the difficult task.

From Canning, Field learned of the difficulties of providing the necessary insulation to keep the copper wires that actually carried the electric current insulated from the conductive medium of the surrounding ocean. It was only a few years earlier that gutta-percha had been found in Malaya and this substance seemed to have the required properties for insulating the current-carrying wire. The material was produced by evaporating the milky fluid of the gutta-percha tree, coagulating the latex, from which an inelastic, firm insulator resulted, one that softened in hot water. It was ideally suited for underwater use where the cold and pressure improved its insulating qualities. This submersion also avoided exposure to sunlight, which had a deteriorating effect on gutta-percha.

In addition to the technical advice sought from Samuel Statham of the London Gutta Percha Works, Field was fortunate in getting the help and advice of Charles T. Bright, an experienced engineer on telegraph and electrical problems, and Dr. Edward O. W. Whitehouse, formerly a physician, who had become an authority on the application of electricity to the problems of telegraphy, though he later proved more of a liability than an asset. They were later joined by Professor Morse to complete the technical staff of the expanded company.

In the autumn of 1856, both Field and Morse were in England. A communication from Morse to Field in the autumn of 1856 apprised the latter of the highly successful results of experiments upon a single continuous conductor of more than 2,000 miles in length, a distance sufficient to cross the Atlantic Ocean, from Newfoundland to Ireland.

"The result had been thrown into some doubt," Morse's long cable continued,

> ". . . by the discovery, more than two years since, of certain phenomena upon subterranean and submarine conductors, and had attracted the attention of electricians, particularly of that most eminent philosopher, Professor Faraday, and that clearsighted investigator of electrical phenomena, Dr. Whitehouse; and one of these phenomena, to wit, the perceptible retardation of the electric current, threatened to perplex our operations, and required careful investigation before we could pronounce with certainty the commercial practicability of the Ocean Telegraph . . ."

Another letter sent by Morse to Field, confirming the ease of telegraphing from Ireland to Newfoundland at commercial speeds, concluded that a cable could carry 14,400 words in a 24-hour day. He added, further, that this number could be increased by adopting a code or system similar to the nautical code, and by this means the transmission speed could be doubled.

The retardation of the flow of current in a long wire covered by insulation and shielded by metallic wires or tapes involved a new phenomenon that became the subject of research by Faraday, and a paper by Edward B. Bright before the British Association in 1854. Unlike a simple bare wire strung on posts in open air, or a comparatively short insulated wire, long insulated and protected cables introduced an inductive and capacitive effect that tended to retard the flow of current. The laws governing this retardation were not fully determined until some years after the Atlantic Cable laying.

Faraday, in answer to a question as to the time it

would take for electricity to pass from London to New York, replied, "Possibly one second!"

Such support from the foremost experimenters and scientists of the United States and Great Britain convinced the British Government of the feasibility of the cable. The British agreed to furnish necessary shipping as an annual subsidy in return for the future use of the telegraph lines for government messages. The United States Government provided similar support shortly (later Lord Kelvin) of Glasgow.

A new company, called the "Atlantic Telegraph Company," was organized on September 26, 1856, by Messrs. Brett, Bright, and Field, and to the board of directors of leading bankers and merchants of London and Liverpool was added Professor William Thomson (later Lord Kelvin) of Glasgow.

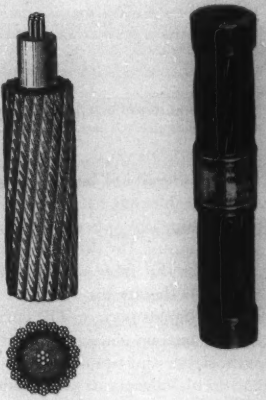
CABLE DESIGN

THE COMPANY turned to its main effort, the fabrication and laying of the cable. Designs and experiments helped determine the form and materials to provide the greatest strength with the lightness and flexibility necessary to handle so long a compound cable under such uncertain and difficult conditions.

The final cable design was submitted to two companies: Glass, Elliot & Co., of London, and R. S. Newall & Co., of Birkenhead, both originally mine cable makers. The specifications for fabrication combined the flexibility of a small rope with the strength to hold six miles of its own weight suspended vertically in water. Without consulting each other, the cable was fabricated at each plant in an opposite lay. Only 6 months were left for the manufacture of 2,500 miles of complex cable, with no time allowed for experimentation or the determination of long-length cable characteristics. When Professor Thomson joined the company as a director, the cable specifications were already in the hands of the fabricators, and the directors were determined to have the cable laid during the summer of 1857.

The conducting core was made by the Gutta Percha Company and consisted of seven wires of no. 22 stranded copper "of the best quality," then covered by three separate layers of gutta-percha, thus forming the core of the cable. Around this were wrapped layers of tarred hemp saturated with a preservative composed of pitch, tar, linseed oil, and wax. Over this was wound the outside covering armor which consisted of 18 strands of no. 22 iron wire, each strand itself composed of six spirally wound strands about a center wire. Both Faraday and Morse favored a smaller rather than larger conductor diameter, fearing the retarding effect of large charging currents. The wire's capacitance was considered more critical than its resistance. The weight of the cable in air was 2,000 pounds per nautical mile and in water 1,340 pounds. The diameter of the cable was slightly larger than $\frac{5}{8}$ inch. A total of 25 miles of heavy shore-end cable was also prepared, 10 miles intended for the Irish coast and 15 miles for that of Newfoundland, which had been found to be more rocky. This heavier conductor consisted of twelve wires of no. 0 gauge and weighed 18,000 pounds to the mile. When completed the entire cable length was tested by a 500-cell voltaic battery.

Thomson recognized the importance of the purity of the copper in the core in determining its electrical resistance, which directly affected the speed of transmission of signals. The cable had been fabricated in 1,200 pieces, each about 2 miles long; these were then joined into eight pieces 300 miles long. During the following year, Thomson tested 45 specimens of this wire and found variations in conductivity among them (according to his scale) of from 42% to 102%. He thereafter stubbornly insisted on a controlled purity of copper content. Mr. Whitehouse saw no value in all this. Professor Thomson, although a director of the Company, held no technical position in the enterprise, being subordinate to Field, Bright, and Whitehouse. His constant courtesy and "laborious humility" never reflected the distasteful situations sometimes forced upon him.



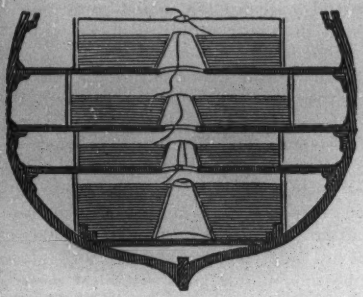
The cable used on the expeditions of 1857 and 1858 had a seven-strand copper core covered by three layers of gutta-percha, a tarred yarn sheath and a protective layer of 18 seven-strand iron wires. After successful laying of the 1858 cable, Tiffany & Co. of New York sold small sections of the surplus cable as souvenirs.

THE EXPEDITION OF 1857

THE OVERCOMING of the political difficulties permitted the directors to begin to organize their resources for the final laying of the cable. In addition to the services given by the U. S. Government in preparing the deep-sea soundings from Newfoundland to Ireland, the U. S. Navy assigned two ships to the enterprise—the *USS Niagara* of 5,200 tons, the largest steam frigate in the world, and the *USS Susquehanna*, the largest sidewheel steamer in the U. S. Navy. The British assigned the 3,200-ton man-of-war *Agamemnon* and the paddle-steamer *Leopard*.

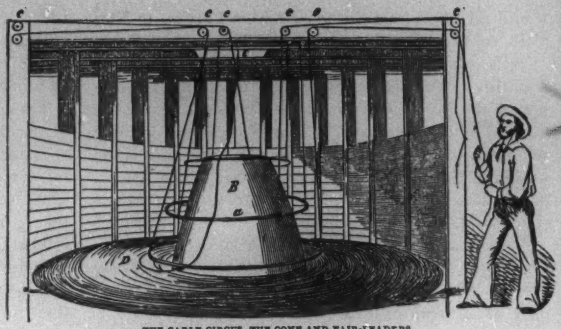
The *Niagara* and the *Agamemnon* each took on nearly 1,300 miles of cable.

With the *Niagara* and *Agamemnon* anchored about a third of a mile apart in the harbor of Queenstown, where all four ships were to rendezvous (it was July 30, 1857), the electricians recognized an opportunity to



SECTION OF THE NIAGARA, SHOWING THE STOWAGE OF THE COILS IN THE FOREPART OF THE SHIP.

The cable was stowed in a "circus" on four decks aboard the *Niagara*, the top end of each coil connecting to the bottom end of the coil above.



THE CABLE CIRCUS, THE CONE AND FAIR-LEADERS.

a—Large iron rings for fair-leaders and to prevent kinking.
B—Cone.
c—Pulleys with iron tricing lines for raising fair-leaders.
D—Portion of cone coiled.
E—Hatchway with the cable going up.

A central cone was surrounded by iron rings that kept the cable from kinking.

test the integrity of both sections of the cable. One end of each cable was accordingly carried over to the opposite ship and spliced to form a continuous length of 2,500 miles. On the *Agamemnon* a battery was connected to the cable and a sensitive galvanometer attached to the circuit. This was found to be complete and the signals perfect. The current was maintained for 2 days but no change was observed. With renewed enthusiasm, the squadron therefore moved on to the harbor of Valentia to get on with the main part of the effort.

Two approaches were considered by the engineers and electricians as to the preferred procedure in laying the cable. The first was for one ship to begin paying out its load until the end of the cable was reached. The other cable was then to be spliced to the section already laid and the second ship would then proceed westward until the Newfoundland shore was reached. The second possible procedure would be for both ships to move to the middle of the ocean, the cable ends spliced, and the cable gently lowered to the ocean bed; the ships then would move in opposite directions, one eastward, the other westward, until their respective shores were reached. The electricians favored the first method and the engineers the second method; the former procedure prevailed.

The accepted plan then was to have the *Niagara* lay the first half of the cable from Ireland to the mid-Atlantic where it would be spliced to the cable on the *Agamemnon* which would then proceed to Newfoundland. The four vessels were to move together and the course of progress was to be constantly reported back to Valentia through the very cable being laid, using "ground" as the return leg of the circuit.

On Tuesday, August 4th, 1857, preparations were made for landing the cable across Valentia harbor.

As August 5th closed, the cable had been secured ashore and the ships were ready to begin their westward journey early the following morning.

They were away the next morning, but the *Niagara* had moved westward only 5 miles when the cable caught in the deck machinery and parted. The ship returned and, again moving westward, lifted the cable out of the water until the end was reached. The heavy shore section was spliced and the journey was continued, but at a reduced rate of only 2 miles an hour, to avoid repetition of the previous accident.

The staff, and also the crew, adjusted themselves to the muffled rumble of the machinery paying out the cable as it moved out without interruption. Slowly, the rate of motion was increased to 4, and later to 5 miles an hour, with a slightly faster speed for the cable to compensate for the unknown conditions at the ocean's bottom. Contact between the *Niagara* and the Valentia telegraph station was constantly maintained in order to assure the staff that no break occurred in the conductor. Progress reports to America were supplemented by messages from the American officers and directors on board, which were taken by ships leaving from England and were moving westward at a greater speed than the cable-laying vessels. The operation continued without any disturbance and the spirits of the officers and crew mounted as the ships continued to their westward goal. Once or twice the alarm sounded when the cable was thrown off the guide wheels, which had been constructed with insufficient width or depth to accommodate the cable, but this was quickly corrected.

In 2 days they had moved over 200 miles westward and the log indicated an increase in depth from 550 to 1,750 fathoms within a span of 10 miles. Soon they were in the deepest section, with 2,000 fathoms indicated, yet all went well.

On Monday evening, August 10th, the signal crew

on board was staggered by a sudden interruption in the current flow. The chief electricians, including De Sauty and Morse, could do nothing to transmit any signals. The engineers were preparing to cut the cable and reel it in when, quite as suddenly, the signal flashed through again, thereby making the mystery even deeper, as the interruption had lasted for 2½ hours. Morse offered the uncertain explanation that at some point the insulation had been stretched beyond contact while leaving the wheels but had, under the pressure of the ocean depth, been forced together again, thereby restoring the insulation.

The uncertainty of cause weighed heavily on the minds of those aboard. The solicitude of the crew for their cable reached touching proportions. Slowly confidence began to be restored, only to be broken again before dawn. To check an excessive rate of pay-out of the cable over the speed of the ship, the engineer had applied the brakes on the drums which, unfortunately, checked too quickly, imposing a heavy strain on the cable; and, as the stern of the ship rose from a trough upwards on a swell, the tension became so great that the cable parted. A shudder ran through the entire ship. The spirit of the crew sagged with the realization that there was nothing to do but to return to England. In a letter to his family Field wrote:

> ". . . Do not think that I feel discouraged, or am in low spirits, for I am not; and I think I can see how this accident will be of great advantage to the Atlantic Telegraph Company . . ."

Field returned to the United States where one of his first tasks was to request from the Government the services of William E. Everett who had been the chief engineer on the *Niagara* in 1857. He had watched the working of the paying-out machinery, had observed its inadequacies, its cumbersome operation and the rigidity with which the brakes were slapped on the drum with a severity sufficient to snap any cable.

Everett devoted himself to a thorough study of the cable machinery, taking 3 months to translate his recommendations into carefully worked out plans and drawings. This resulted in a smaller and lighter assembly requiring only about a third of the deck space and weighing only a fourth of the machine installed earlier on the *Niagara*.

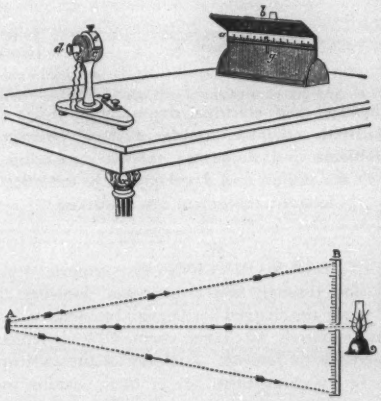
On March 9th, 1858, the *Niagara* again sailed from New York under Capt. Hudson, and at Plymouth took her share of the cable aboard.

Unlike the 1857 expedition in which both ships laden with cable moved westward together, one lowering her cable, the other ready to splice her cable in mid-ocean and then to continue, it was decided that for the 1858 expedition the splice would first be made in mid-ocean and the ships would then move apart.

MARINE GALVANOMETER

One of the most important innovations of this expedition was the introduction of the newly invented mirror galvanometer developed by Thomson. This sensitive instrument became one of the vital links in the eventual successful laying of the cable. Then called a "marine galvanometer," the instrument consisted of a small but exceedingly light steel magnet to which a tiny reflecting mirror was attached. This assembly weighed no more than a grain and was suspended from its center by a filament of silk. Around this was wound a coil of very thin insulated copper wire. When an electric current passed through the surrounding coil, the suspended magnet would move in proportion to the magnetic field built up by the current in the coil. A ray of light passing from a shaded lamp through a slot in a screen would be reflected from the mirror upon a graduated scale. A very slight motion of the suspended magnet and mirror would, therefore, produce a magnified motion upon the scale which could be readily noted and measured by the observer. A combination of direction, from the central zero point, and the magnitude of motion, provided a code. Zero position on the filament and the earth's magnetism would restore the suspended magnet to its neutral point. A thumb-screw placed over the filament would adjust it to its zero position. This instrument was capable of receiving 20 words a minute, compared with a rate of 2 words a minute with older apparatus. Since an operator could not watch the instrument and record his readings at the same time, a team consisting of a "reader" and a "writer" was necessary to receive a message.

Thomson formulated a law for the speed of telegraphic sending which stated that for a given conductor diameter, the speed decreased as the square of the cable length increased. This recognized the capacitance of a



Thomson's marine galvanometer consisted of a very small steel magnet with a mirror fastened to it suspended by a silk filament within a coil through which the signal current was passed. A light source from lamp *b* passed through the slot *g*, was reflected from the galvanometer *c*, upon the scale *a*.

wire surrounded by an insulating cover and metallic sheath, all laid in a conducting medium—salt water. Thomson's "doctrine of squares" of speed and cable size was challenged by Whitehouse in a paper in 1855; Thomson considered this account good, but the conclusions fallacious.

On June 25th, the squadron of four ships, the *Niagara* and *Agamemnon*, supported by the *Valorous* and *Gorgon*, met in mid-ocean. On Saturday, June 26th, the splice between the cables on the *Niagara* and *Agamemnon* was made and this center joint was slowly lowered to the bottom of the sea. The ships parted, each moving in its own direction attended by its consort. But they had not separated more than 3 miles when the cable caught in the machinery on board the *Niagara* and broke. Thereupon, by prearrangement, both ships returned to their mid-Atlantic point; the cables were again spliced and the ships were again pointed in their opposite directions.

All went well when, at a separation of about 80 miles, there was a sudden break in the current. This happened at 3:00 a.m. on Sunday morning, June 27th, when Thomson sadly announced a complete break of circuit. The signal gun was fired and a blue light notified the *Valorous*, attending the *Agamemnon*, that there was trouble on the *Agamemnon*. It was thought that the break had occurred on the *Niagara*, but those on the *Niagara* thought the break had happened on the *Agamemnon*. The ships were again rejoined; Field with the electricians from the *Niagara* joined Thomson on the *Agamemnon* and a comparison of the logs was made. This showed the astonishing fact that a break had occurred at exactly the same time but at a distance of not less than 10 miles from each ship.

Once again the cables were spliced in mid-ocean and the ships slowly parted. The speed of the *Agamemnon* of 2 knots was increased to 3, then to 4, showing a cable strain of 2,000 pounds. This rate was thereafter maintained. On the *Niagara* the same cautious condition prevailed. Conversations were prohibited and everyone was silent and alert. Carefully the cables slid over the wheels until 100 miles of cable lay safely on the ocean bed, then 150, now 200 miles! Spirits slowly rose, but hardly had another day passed when, on Tuesday, June 29th, the current suddenly again stopped. It seemed that the cable had broken about 20 feet from the *Agamemnon* stern. The ships then reluctantly headed for Queenstown.

(The second installment will appear in the October issue.)

Nuclear Radiation and Electronic Equipment

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ASSOCIATE MEMBER AIEE

Chemical and electrical degradation occurs in electronic equipment under nuclear radiation. Problems and suggested solutions associated with the design and development of radiation-tolerant equipment are discussed.

NUCLEAR RADIATION causes material degradation through several processes. Ionizing radiations, the charged particles and gamma rays, cause organic materials to change chemically and electrical conductivity to increase. Energetic neutrons displace atoms by knocking them out of their position in the structure of the material; and the displaced atoms, as charged particles, also cause ionization and secondary displacements. Less energetic neutrons may be absorbed by a nucleus. The new isotope may be unstable and decay in any of several processes (fission, alpha, beta, or gamma emission) each of which may cause ionization. Material degradation then is caused by ionization, displacement, and transmutation which are observed as chemical changes and increased conductivity.

Increased conductivity is a function of the current carriers available and their ability to move. (Mobility is a characteristic of the material under consideration.) Ionization generates large numbers of current carriers (electrons and ions or holes). The degree of ionization is a direct function of the intensity of the nuclear flux. Thus, the increase in electrical conductivity is related to the intensity of the nuclear flux as illustrated in Fig. 1.[1]

Chemical changes, on the other hand, are a function of the time integral of the dose rate. Ionization, displacement, and transmutation are discrete events. For a given flux intensity (dose rate) the number of events per unit

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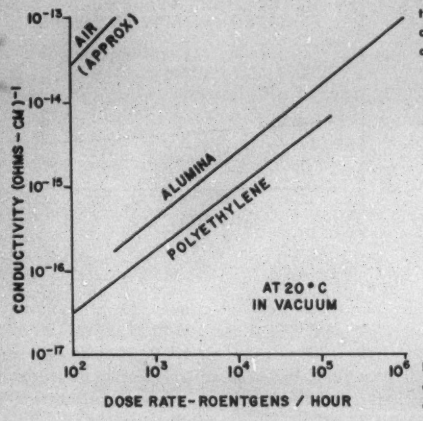


Fig. 1. (*left*) Variation of conductivity as a function of dose rate.

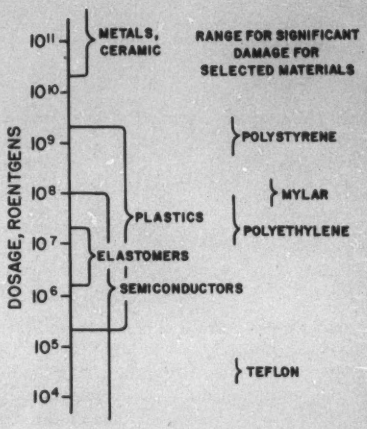


Fig. 2. (*right*) Scale of relative tolerance of materials.

time can be calculated. Because the reaction during an event can "go" in any of several processes, it is difficult to define the number of events required to bring about a specific effect, but a range of the time integrals of dose rate (dose) can be determined. Fig. 2 illustrates the range of doses to obtain an effect for several materials.[2] As only a small portion of the induced changes revert, chemical changes are permanent in contrast to the transient conductivity changes.

EFFECTS ON AMPLIFIER

In electronic equipment chemical changes and increased conductivity can bring on failure or malfunction. A simple audio amplifier may be used to demonstrate radiation effects in electronic components. Fig. 3 shows an amplifier and its equivalent circuits. As indicated by the equivalent circuit, the transfer function of the amplifier (the ratio of the output signal to the input signal, E_{out}/E_{in}) is determined by the operating characteristics of the vacuum tube and its associated resistors and capacitors. The use of equivalent circuitry implies that the characteristics of the components remain constant. In practice, these values may vary; but the designer, through experience, has learned to accommodate the inconsistencies. The problem is to evaluate the radiation induced changes and learn to accommodate them.

The amplifier depicted in Fig. 3 has three elements which will be considered: the capacitor, the resistor, and the vacuum tube. A number of studies on the tolerances of vacuum tubes to nuclear radiation have been reported.[3-4-5] Several types were found which are essentially unaffected by radiation to doses which exceed the radiation tolerance of the capacitors. Wire-wound resistors are also insensitive to nuclear radiation. Capacitors then are the most sensitive component.

Fig. 4 shows the characteristic behavior of two commercial capacitor types. The behavior of capacitors having Mylar and Teflon dielectrics illustrates the effect of nuclear radiation; that is, large changes of insulation resistance (dielectric conductivity) and little or no change of capacitance. As noted in Fig. 2, Teflon is quite susceptible to radiation damage while Mylar is not so easily affected. Both capacitor types were exposed to the same environment and in sufficient quantity to achieve reliable results.

The behavior of resistors is shown in Fig. 5. Wire-wound devices are not seriously affected, but the effect of displacements in the thin film varieties is to distort the film, causing a reduction in conductor cross-sectional area. As illustrated in the figure, resistance values increased. It is advantageous to use wire-wound devices when the required values and sizes are available. (Because they are temperature sensitive and vary with age, carbon composition resistors are not considered for this application.)

The foregoing data indicates the effects induced by nuclear radiation on the components of the amplifier circuit. Fig. 6 shows the initial circuit modified by the

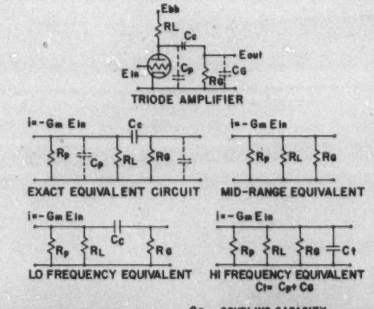
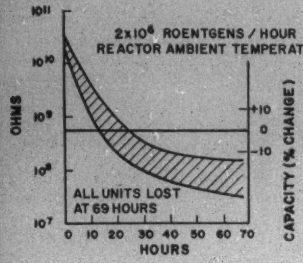


Fig. 3. Electronic amplifier and equivalent circuits.



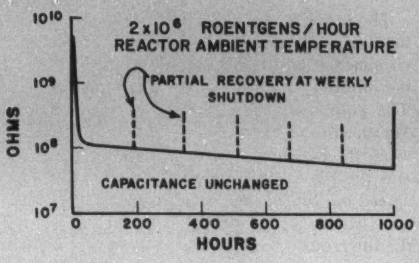


Fig. 4. *(left)* Resistance and capacitance of Teflon capacitors. *(right)* Resistance of Mylar film capacitors.

variables caused by nuclear radiation and the modified equivalent circuit.

It should be noted that catastrophic failure of the amplifier occurs when a capacitor develops a short circuit. This also is true for the tube or the resistors: ie, drastic nonreversible changes are considered component failure and will cause amplifier failure. Since they may be accommodated in the circuit design, repeatable or reversible changes do not necessarily constitute component failure.

Analysis of the equivalent circuit in Fig. 6 indicates that the radiation-induced current paths do not appreciably alter the amplifier's transfer function except at low frequencies. Should the input resistor paralleling R_a have a high ohmic value, it is possible to obtain some attenuation of the input signal; or should resistor R_g of the amplifier have a high value, the parallel stray leakage may cause some attenuation. The more important leakage path shunts the coupling capacitor. The coupling capacitor is often called the blocking capacitor because one of its purposes is to restrict d-c flow. When the blocking capacitor conducts, the d-c voltage level at the amplifier output is increased. Normal amplifier design assumes that no direct current flows through the coupling capacitor. R_g values are usually greater than 10^5 ohms. It can be seen from the data in Fig. 4 that capacitor shunt resistance may decrease to 10^7 ohms or less. The grid-leak resistor and the blocking capacitor leakage resistance form a voltage divider which applies a d-c voltage to the amplifier output or to the next stage of the circuit. The magnitude of the d-c voltage is a function of the resistance ratio R_c/R_g. Since R_c may be as low as 10^6 ohms and R_g is frequently 10^6 ohms or more, it is possible to apply 50% of the plate voltage at the amplifier output. Although the a-c fed into the amplifier may not be seriously distorted by its action, the variable d-c voltage at the output will change the operation of succeeding equipment.

Radiation then produces two effects on electronic equipment—transient amplifier malfunction or catastrophic failure through drastic component change.

The preceding discussion has assumed specific and constant environmental conditions. These conditions are representative only. Each application will present new and different conditions which may vary with time and include other environmental stresses such as temperature extremes.

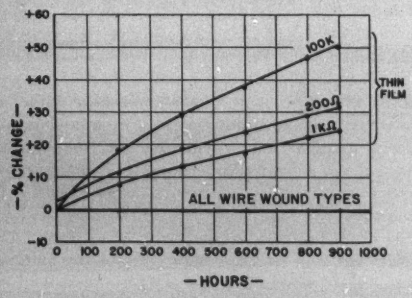
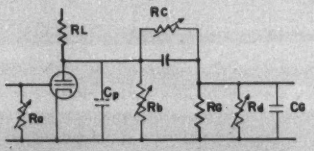
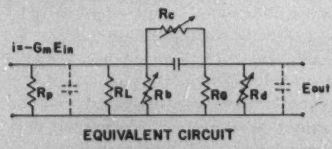


Fig. 5. Typical behavior of resistors irradiated in the Oak Ridge National Laboratory (ORNL) graphite reactor at reactor ambient temperature. Total integrated dose—2 × 10^8 roentgens.



Gm = TUBE TRANSCONDUCTANCE
Rp = PLATE RESISTANCE
RL = COUPLING LOAD
RG = GRID-LEAK RESISTANCE
Cc = COUPLING CAPACITY
Cp = TUBE PLATE-CATHODE & STRAY CAPACITY
Cg = TUBE IN-PUT CAPACITY + ASSOCIATED STRAY CAPACITY
Ra = INPUT STRAY LEAKAGE
Rb = PLATE-CATHODE STRAY LEAKAGE
Rc = CAPACITOR SHUNT LEAKAGE
Rd = OUTPUT STRAY LEAKAGE



EQUIVALENT CIRCUIT

Fig. 6. Electronic amplifier showing radiation induced current paths.

The problems associated with designing and developing radiation tolerant equipment begin with the environment. The range of dose rates to be expected and the duration of each must be established or predicted. The equipment life expectancy should be specified. Maintenance procedures should be described. Only when the environmental specification has been written and the life requirement and maintenance procedure agreed on, can the initial electronic design begin. Material choice is limited by the maximum dose rate and the life required. System design is restricted by the materials and techniques which can be used.

DESIGN COMPROMISES

THIS DESIGN PROCEDURE dictates a series of compromises. The cost of a completely inorganic system is exorbitantly high, and it is difficult to obtain good performance while meeting minimum weight and volume requirements. The normal array of components contains materials known to be sensitive. Selection of components constructed of more tolerant materials still does not give unlimited life. Even though a satisfactory life expectancy may be obtained, performance and size may be unsatisfactory.

To demonstrate, again consider the amplifier of Fig. 3. Fig. 7 indicates the probable life expectancy for electronic equipments containing the indicated materials. While it is not possible to predict the interaction of

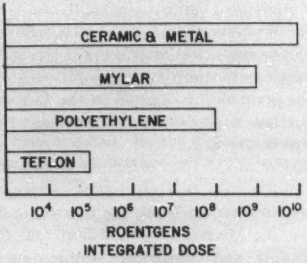


Fig. 7. Life expectancy of amplifier containing various materials.

several materials and combined stresses using the available data, the analogy with the weakest link of a chain is applicable. Long life may be realized in many instances, but the weak material will always limit the life of its component.

For operation at a low rate, only a few limitations apply. It may be feasible to use Teflon. As lifetime requirements increase, the weak materials begin to drop out, even at very low dose rates. If high temperatures are expected, life is considerably shortened. At high dose rate, only inorganic systems will give acceptable life expectancies.

Materials are not the only limitation. Circuit design is restricted. Transient conductivity limits the maximum resistor value which is also restricted by the larger changes of high value resistors.

Fig. 8 is the schematic of an amplifier designed to tolerate high dose rates for 1,000 hours or more. Note the low resistor and capacitor values—56,000 ohms and 0.01 microfarad maximum. There are no organic materials used. The amplifier has a gain of 40 db from 10 kc to 1,500 kc over a wide temperature range and will meet military specifications. It is an excellent example

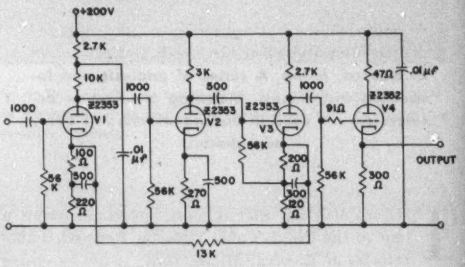


Fig. 8. Radiation tolerant amplifier.

of the application of the points presented in this discussion of nuclear radiation effects on electronic components.

DESIGN SUGGESTIONS

HERE ARE SOME SUGGESTIONS for designing radiation-tolerant electronic amplifiers:

1. Keep resistance values low.
2. Use materials compatible with the environment.
3. Avoid large capacitor values.
4. Keep the circuit simple.
5. Design the system with these restrictions in mind.

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ARRIGO CASTELLANI

A single all-embracing unit forms the new research laboratories of the Pirelli Cable Division at Bicocca, Milan. A series of analysis and inspection instruments, including an electron accelerator, are used in the manufacture of every new product.

THE FEATURE that is most impressive about a visit to the Pirelli Cable Division Research Laboratories at Bicocca, Milan, Italy, is the extensive investigation, trial, inspection, and testing work which is carried out prior to and accompanying the manufacture of what is, on the face of things, a most simple article: an electric cable.

The development of a cable is prepared for and supervised by a combination of analysis, inspection, and measuring devices which employ all the most recent discoveries in the electronic, chemical, and mechanical fields.

The need to start anew and on a more rational basis in the light of various organizational criteria decided Pirelli to centralize and enlarge their various research laboratories, which formerly were spread over a number of buildings. The result is a single group of research laboratories ideally situated in suitably designed and planned buildings, occupying a covered area of approximately 116,000 square feet and an uncovered area of approximately 25,600 square feet.

They have a staff of 180, of whom 80 are graduates or otherwise qualified.

LONG HISTORY BEHIND THE LABORATORIES

THE LABORATORIES consist of one main building and two others joined to it, one for very-high-voltage experiments, the other a massive shielded building for electron irradiation work (Fig. 1). Although it is only since May 1957 that the Research Laboratories have been in operation in their present state, they have, nevertheless, been in existence for 40 years. It was Luigi Emanueli, the late vice-chairman of the company, who, in 1925, realised the necessity for such an instrument of scientific investigation and technical research, and it was he who founded the laboratories. In 1938, they had already reached a considerable size, but they still lacked unity. When it was possible for the plant to return to Bicocca from Trezzo d'Adda, where it had been transferred for the sake of safety, the buildings which had housed it before World War II were no longer available, and the arrangements then made could only be tolerated on a temporary basis. The situation demanded new planning, and, in 1955, work was begun on the unification of the laboratories.

The large main building, whose clean lines dominate the Viale Sarca, is the work of architect M. Righini. Air conditioning maintains a constant temperature of between 20 and 26 C and a relative humidity varying between 50 and 70%; special requirements are met by six rooms where special air-conditioning equipment ensures constant temperature and humidity with very small variations.

Following modern organizational methods, the four principal laboratories are named, not according to the actual branch of science (chemistry, electrotechnics, physics) as in the past, but according to the field of activity with which they are concerned: Power Cable Laboratory; Telecommunications Laboratory; Rubber Laboratory; Oils, Plastics, and Miscellaneous Laboratory. Each laboratory is, as a rule, subdivided into two sections, one dealing with fundamental scientific and technical problems, the other with new techniques and developments. The latter section, besides carrying out its own technical development tasks, has some technicians permanently located in the factory to assist the production departments but constantly in touch with the section itself.

In addition to the four principal laboratories, there are four others also of considerable importance: the Laboratory for Physical Tests, the Electronic Apparatus Laboratory, the Mechanical Workshop, and the Center of Theoretical and Statistical Studies. In addition, there is the Materials Testing Laboratory, which is concerned with the inspection and approval of raw materials (paper, fabrics, oil, bitumen, rubber, plastics, and metals) and their relative specifications. Finally, there is the library, with its 2,000 technical volumes and 4,500 periodicals, and also the Patents Liaison Office, which come under the control of the Research Laboratories.

WORK OF LABORATORIES

HUNDREDS OF TYPES of cables are studied and perfected in the laboratories. A cable has just been developed which will carry a load of 800 mw (megawatts) at 400 kv underground. Recently, a Y joint insulated with a special epoxy resin compound was produced which is undergoing laboratory trials with the Consolidated Edison Company of New York, N.Y., and

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Fig. 1. The Electron Irradiation Laboratory (*right foreground*). The Van de Graaff electron accelerator is housed in this massive heavily shielded building. Main laboratory building can be seen in the background.

Fig. 4. The Technological Section of the Oils, Plastics, and Miscellaneous Laboratory, where special efforts have been made in research on insulation materials.

Fig. 2. Impulse test room in the Dielectric Research and Testing Section of the Power Cable Laboratory. The 800-kv impulse generator shown can be coupled to a special inductance which enables damped oscillatory discharges to be produced that simulate switching surges.

Fig. 3. The Alternating-Current Testing Section for cables and accessories of the Power Cable Laboratory where voltages up to 1.05 million volts are obtainable.

which, also rated at 70,000 volts, has enough safety margin for it to be used up to 100,000 volts. In the Power Cable Laboratory, there are also two impulse generators, the larger of which can produce electric discharges up to 2.5 million volts and 60 kilojoules. These generators are used for testing joints, terminals, and cables (Fig. 2). A group of three transformers provides a total voltage of 1.05 million volts and 1,500 kva. (See Fig. 3.)

Oscillographs measure wave shapes and Schering bridges measure dielectric losses. Some 10 other transformers for voltages between 50,000 and 250,000, a movable d-c generator for 750,000 volts, and two d-c rectifier sets for 200,000 volts complete the equipment of the Power Cable Laboratory.

Cross-talk meters, echo test sets, impedance bridges, complex coupling measuring bridges, attenuators, oscillators, and amplifiers of all types are grouped together in the Telecommunications Laboratory, where there is also a secondary frequency standard, accurate to one part in 1 million, enabling direct readings to be taken of frequencies up to 220 mc.

The importance of rubber as an insulant in the manufacture of cables, because of its good insulation properties and its resistance to wear, fracture, and humidity, is realized when visiting the Rubber Laboratory. This laboratory is equipped with all the latest apparatus for measuring, checking, and preparing laboratory-scale quantities of mixes of natural and synthetic rubber: viscosimeters, plasticity testers, abrasion meters, mixers, autoclaves, mills, ultrathermostats and special thermostats, dispersion apparatus for pigments, and special emulsions and microscopes.

No less impressive is the test and research equipment in the Oil, Plastics, and Miscellaneous Laboratory. Here special efforts have been made in research on insulation materials, such as flexible insulant for extrusion or tapping onto cables and rigid insulants made into moldings for cable accessories. The scientists in this department have already developed two special insulators—"Sintenax" (trade name of special polyvinyl chloride compound for 15- to 20-kv power

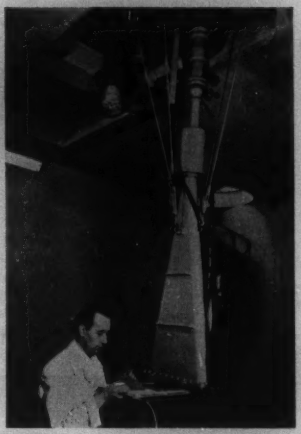

Fig. 5. Two views of the first Van de Graaff electron accelerator to be used in Italy for industrial research. (*Left*) The upper part of the accelerator is shown with the pressure vessel in which the electron generator and discharge tube are located. (*Right*) The lower part of the accelerator with the vacuum equipment, the electron beam deflector and the supporting device for the material that is to be irradiated.

cables) and "Voltalit" (trade name of a special epoxy resin compound for producing extra-high-voltage cable accessories). Voltalit has been used to manufacture 132,000-volt stop-joints for 3-core cables (for Sweden and the United Kingdom). One section specializes in making samples of special papers for use in the cables.

Two technological sections under the respective control of the Rubber Laboratory, and the Oils, Plastics, and Miscellaneous Laboratory (Fig. 4), are specially equipped for small-scale manufacture of insulated and covered cables in both rubber and plastic materials. They are equipped with Banbury machines, mixers, calenders, extruders, vulcanising pans and presses. Thus, they are able to experiment on a small scale with items which later will be manufactured industrially.

The Laboratory for Physical Tests is equipped to carry out mechanical, optional, and thermal tests on semifinished and finished products; X-ray equipment, various types of microscopes, ultrasonic test sets, photometers, infrared spectrophotometers, and ultraviolet spectrographs all study the fine structure of the materials themselves, the samples, and the finished articles. Dynamometers for loading up to 10,000 kilos, extensometers, and other apparatus, test the tensile strength of materials. Temperature of –75 C are obtainable in a special refrigerator.

The Van de Graaff electron accelerator is part of the Laboratory for Physical Tests (Fig. 5); this is installed in a building which vaguely resembles a fortress and which is also the work of architect Righini. The walls protecting the personnel from radiations are almost one meter thick, and are built of a special concrete having a much higher density than normal. The electrons, accelerated by an adjustable voltage of from 750,000 to 2 million volts, bombard the materials, which are either stationary or move on a conveyor belt below the electron outlet. The molecular structure of many materials alters when they are bombarded in this way; cross-bonds are formed and the molecule which results is more stable. In this way, the materials are made to develop their own properties in relation to the particular use for which they are designed. The accelerator also can be used for the vulcanization of rubber.

The construction and repair of special apparatus used in the various departments is carried out in the Electronics Apparatus Laboratory. The small workshop with which it is provided carries out any structural alterations and adaptations of existing equipment and designs, and constructs equipment for particular applications. This laboratory is equipped with oscillators of various types, stabilized power supplies, electronic voltmeters, oscillographs, quality control instruments, valve testing apparatus, and universal bridges for measuring resistance, capacitance, and inductance.

The Center for Theoretical and Statistical Studies is in charge of all mathematical research. This center deals at the highest theoretical level with problems which nowadays require a high degree of specialization and which consequently cannot be solved by the other laboratories. It possesses modern automatic calculating machines and works in co-operation with the Mathematical Computing Department of the Milan "Politecnico," whose large electronic calculating machine it uses under the control of its own staff and operators, whenever the complexity and scope of the calculations renders this necessary.

A E E I
75th Anniversary

Control of Reversible Induction Motor Drives

WERNER LEONHARD
ASSOCIATE MEMBER AIEE

DURING the past several years, saturable reactors and self-saturating magnetic amplifiers have found increasing application for the control of reversing induction motor drives for intermittent slow-speed duty. The restriction to intermittent duty is imposed by the low motor efficiency at slow speed. With speed feedback, which is usually included, the reactor-controlled induction motor possesses adjustable speed characteristics and speed-torque curves similar to those of a d-c adjustable voltage drive. The minimum no-load speed is about 1 per cent, and the speed drop between no load and full load is in the order of 5 to 10 per cent of synchronous speed.

The principle of primary reactor control can be described and four of the many possible circuits analyzed with regard to their "open-loop" performance, i.e., without the speed feedback. For example, in Fig. 1, a standard induction motor with large external rotor circuit resistance is shown; the primary motor terminals *a*, *b*, and *c* are connected through a network of six saturable reactors, which are arranged in two groups, g_1 and g_2, to the 3-phase line 1, 2, and 3. Alternatively, control current is applied to one group of reactors while the others remain unexcited. Consequently, the motor is supplied with adjustable and symmetrical voltages of alternative sequence, resulting in variable torque of alternate direction. When both control currents, I_{C1}, I_{C2}, are zero, the motor voltages and torque are near zero. This is a convenient possibility for material handling operations with frequent stand-by periods, because no line contactor needs to be opened. This relieves the motor of frequent inrush currents and voltage surges.

The circuit in Fig. 1 can be simplified by omitting the two reactors between line 3 and motor terminal *a*. This introduces asymmetry in the motor voltages and currents, but the asymmetry is moderate for practical combinations of speed and secondary resistance. The advantage of the six-reactor circuit, where the motor currents could be reduced to low stand-by values merely by controlling the reactors, is maintained in the four-reactor circuit.

Another variation consists in combining the remaining four reactors into two saturable transformers, each having two load and one control windings. When estimating the component size and the required control power, it is found that this circuit is still more economical than the previous one but now a considerable asymmetry exists in the motor voltages and currents. In particular, the motor cannot be "disconnected" from the line by static control, because, when both saturable transformers are de-excited, the motor can still operate on single-phase.

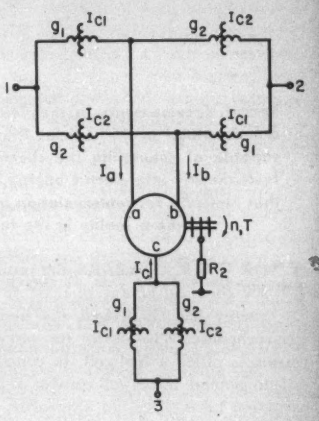

Fig. 1. Saturable reactor control of wound rotor induction motor.

The last circuit under consideration has been frequently applied to hoist controls. It uses an isolation transformer establishing a fourth line phase opposite to phase 3 (Fig. 1) such that the vector diagram of the four line voltages forms a rhombus. Two saturable reactors are connected in series between lines 3 and 4 and the motor is supplied from lines 1 and 2 and the tie point between the two reactors. Again, by alternately exciting the two reactors, the ratio between positive and negative sequence motor voltages can be varied ideally between 0 and ∞. When both reactors are unexcited, the motor operates on single-phase. In these aspects, as in the rating of the main components, this circuit is closely related to the saturable transformer scheme.

Four circuits are compared on the basis of the approximate motor losses, a rating factor for the major control components and the reactor control power, all defined for a typical operating point of a hoist drive. The results indicate a cost advantage for the two "single-phase" control schemes in contrast to the operational advantages to be gained with the two "3-phase" circuits. They are preferable when close speed regulation and fast response are desired. While the fully symmetrical, six-reactor circuit appears justified on large drives (several 100 kw), the four-reactor scheme is recommended for the lower ratings where some asymmetry in the motor supply can be tolerated.

Digest of paper 58-1176, "Elements of Reactor Controlled, Reversible Induction Motor Drives," recommended by the AIEE Industrial Control Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Pittsburgh, Pa., Oct. 26-31, 1958. Published in AIEE *Applications and Industry*, May 1959.

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Advances in Basic Sciences
I. Fuel Cells

D. L. DOUGLAS

Recent developments in the field of fuel cells are described in this article. These devices are capable of converting the chemical energy of fuels directly into electric energy. It is predicted that fuel cells for central station power may become a reality in the future.

FOR OVER 150 YEARS, the problem of converting the chemical energy of fuels directly into electric energy has challenged the best efforts of many electrochemists. The device for carrying out this conversion is called a fuel cell. In common with galvanic cells in general, a fuel cell consists of an anode at which oxidation takes place, an electrolyte, and a cathode at which an oxidizing agent is consumed. Fuels of interest are those conventionally used for the production of power and heat. Hydrogen must be added to the list for reasons which will become apparent later on. The only oxidizing agent of importance is molecular oxygen, either in pure form or in air.

Many excellent reviews of past fuel cell research and development have appeared in the literature.[1-5] This article is concerned with a review and appraisal of the more recent developments, particularly with regard to the possibility of generating central station power.

ENERGY CONVERSION

Thermodynamic Principles. The conversion of the chemical energy of a fuel into electric energy by means of a heat cycle—as in a modern coal-burning power station, for example—suffers from an unavoidable limitation imposed by thermodynamics. This limitation applies to any process converting heat into work and derives from the nature of heat itself. When heat is converted into another form of energy, it must fall from an absolute temperature T_H to absolute temperature T_C, and the maximum fraction that can be converted under ideal condition is $(T_H - T_C)/T_H$.

Let us see what this means in modern practice. Under good operating conditions, T_H and T_C will be near 1,050 F and 80 F, respectively—corresponding to a Carnot efficiency of 64%. The over-all efficiency of the power plant might be 40%. That this efficiency approaches the Carnot so closely is an eloquent tribute to modern engineering. It is likely that further appreciable improvement will entail raising T_H, thus making greater demands upon construction materials. There is every reason to expect such improvement, but it will not come easily.

Conversion of the chemical energy of a fuel into electric energy by electrochemical means, as in a fuel cell, never involves the conversion of heat into work. The process is essentially isothermal and escapes the Carnot limitation. Actually, heat changes do occur in an operating fuel cell. These, while important in certain cases, are incidental to the primary conversion of the free chemical energy to electric energy. This possibility of avoiding the Carnot limitation constitutes the main reason for interest in fuel cells.

The thermodynamic principles are represented by the relationship

$$\Delta G = \Delta H - T\Delta S$$

where, for the net cell reaction, ΔG is the change in free energy, ΔH the enthalpy (heat content) change, and ΔS the entropy change. The maximum electrical work which can be obtained under reversible operation of the cell is equal to ΔG, the change in free chemical energy. For over-all engineering considerations, we are interested in the fraction of the total heat energy converted into electric energy. Clearly, the efficiency in the ideal case is

$$\eta_{id} = \frac{\Delta G}{\Delta H} = 1 - \frac{T\Delta S}{\Delta H}$$

The maximum possible efficiency then depends on the relative magnitude and sign of the waste heat or entropy term. Fortunately $\Delta S \approx 0$ for the important combustion reaction $C + O_2 \rightarrow CO_2$. Thus, any fuel cell system which accomplishes this over-all reaction will have a high theoretical efficiency. No useful cell reactions with a positive entropy change, which would result in an ideal efficiency greater than one, are known.

Given an electrochemical system or cell reaction, the electrochemist is likely to be more interested in the efficiency on the basis of the free energy. This he will take to be the ratio of the operating cell voltage to the theoretical open-circuit voltage calculated from the relation

$$-\Delta G = nE^\circ F$$

where n is the number of electrons involved in the reaction, F is the Faraday constant, and E° the theoretical open-circuit voltage. A more precise measure of the free energy efficiency takes account of any losses from side reactions of the fuel as in the expression

The first of a proposed series of articles recommended for publication by the AIEE Basic Sciences Committee.

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$$\eta = \frac{E_{cell}\, i_{cell}}{-\Delta G\, \phi}$$

where E_{cell} and i_{cell} are the voltage and current being drawn and ϕ is a flow rate factor.

Fuels and Their Economics. In the considerable literature on fuel cells, devices have been proposed for almost every conceivable fuel. The most attractive fuel cell would be one utilizing coal or the hydrocarbon liquids directly. Unfortunately, these fuels have very poor electrochemical properties. Inordinately high temperatures (1,000 C and above) are required to make carbon or coal ionize at an electrode. In addition, disposition of the impurities or ash normally present in coal is a formidable problem. Similarly, efforts to make saturated hydrocarbons react electrochemically, i.e., at an electrode, have met with little or no success.

Two fuels which have been found to be electrochemically active are hydrogen and carbon monoxide, the former being much more reactive than the latter. Because these fuel gases can be readily generated from coal and hydrocarbons, they are of interest for large-scale application in fuel cells. Some estimates of fuel costs are given in Table I. The cell is assumed to be 70% efficient (free energy efficiency) in this table. These values must be taken as rough estimates at best, and are to be compared with the 3 mills per kwhr fuel cost of an average modern steam plant. However, the fuel cost story does not end here. Gorin has pointed out that the promise of the fuel cell can best be realized in integrating the cell and gasifier to utilize the waste heat from the cell to carry out the endothermic gasification reactions.[6,7] In a recent paper he shows that the fuel cost for power based on coal used in such an integrated plant (70% efficient cell) will remain competitive with even the most optimistic estimates of future nuclear fuel costs.

Table I. Fuel Costs for Coal Gasification Products

	Composition by Volume, %					Production Cost,* $ per 1,000 cubic feet	Fuel Cost,† mills per kwhr	Reference
Fuel	H_2	CO	N_2	CO_2	Hydrocarbons			
Hydrogen	99.5	—	—	—	—	0.74	14	6
Synthesis Gas	40	40	1	19	—	—	5.4	7
Blue Water Gas	50	40	6	4	—	0.25	5.1	8
Producer Gas	13	30	50	4	3‡	0.078	3.6	8
Coal Gas	51	11	9	2	28‡	0.41	13.7	8

* Coal cost assumed to be $5 per ton.
† Fuel cell assumed 70% efficient at 900 degrees Kelvin.
‡ Hydrocarbon fraction ignored in fuel cost calculation. For coal gas, the selling price of the coke produced is included in the gas production cost.

Until fuel cells have been developed at least to the pilot stage, no reasonable estimate of the investment cost of the power produced can be made. However, both the gasifier and the cell units themselves are, in principle, much simpler devices than the boiler–turbine–generator complex of modern generating stations. The determining factor in the investment cost will be the life of the cells. If the life is sufficiently long, this cost may be well below that of present central power stations.

REACTION KINETICS IN FUEL CELLS

Gas-Diffusion Electrodes. With one exception, all fuel cells under development today require for the generation of electricity the reaction of fuel and oxidant in gaseous form directly at their respective electrode surfaces. Only a little reflection is required to recognize some of the difficulties this requirement involves, since the reaction between gas, electrolyte, and electrode can take place only at the 3-phase boundary. While in theory this boundary is just a line–having but one dimension in space–in reality a finite reaction zone must exist. The problem was stated eloquently by William Grove in 1842 thus, "As the chemical or catalytic action in the experiment detailed in that paper [an earlier paper describing the first hydrogen–oxygen cell] could only be supposed to take place, with ordinary platina foil, at the line or water-mark where the liquid, gas and platina met, the chief difficulty was to obtain anything like a notable surface of action."[8] Grove solved his problem by building 50 cells of platinum foil, after failing in attempts to make a spongy platinum. With the latter, he was on the right track and he knew it. In present-day fuel cells, the usual method of extending the area of the reaction zone is to fabricate the electrode as an electronically conducting porous structure which separates the gas (fuel or oxidant) and the electrolyte phases. These ideas are shown schematically in Figs. 1 and 2.

The design of the electrodes for long operating life at high current density is by far the most serious problem facing fuel-cell workers. Each electrode material, reactant gas, and electrolyte system is unique, involving particular methods of obtaining the required pore size distribution in a form consistent with fabrication in a usable form. Despite this uniqueness, some general requirements which must be met by any electrode can be listed:

1. High electrical conductivity.
2. Catalytic properties to increase reaction rates.
3. Stable pore size distribution to maintain electrolyte–gas interface at proper position within electrode over wide range of load currents and for long periods of time. In other words, the electrode must neither become "drowned" nor leak gas into the electrolyte.
4. Corrosion resistance.

It is instructive to consider the reaction at a gas electrode in more detail. The following steps in the mechanism may be proposed, more or less in order of occurrence:

1. Transport of gas molecules into pores.
2. Chemisorption of gas onto electrode surface, involving dissociation into atoms in the case of hydrogen.
3. Transport of chemisorbed atoms or other species.
4. Reaction of chemisorbed species with ionic species in the electrolyte–electron transfer step.

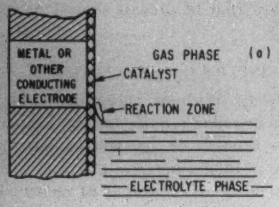

Fig. 1. Enlarged diagram showing the 3-phase reaction zone of a gas-diffusion electrode.

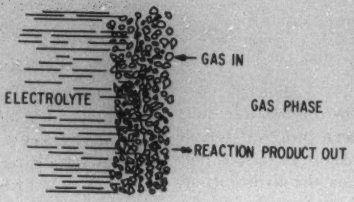

Fig. 2. Diagram showing a section cut through a gas-diffusion electrode made of a porous conducting material.

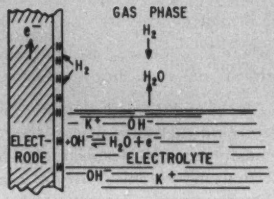

Fig. 3. Suggested reaction mechanism for hydrogen at the anode in aqueous potassium hydroxide electrolyte.

5. Diffusion of ionic species in electrolyte to or away from electrode.

6. Transport of reaction product gas out of pores, countercurrent to flow of reactants.

Any one of these steps may be rate controlling; however, proper selection of pore size distribution and sufficient porosity will minimize difficulties with the gaseous and ionic diffusion steps, i.e., steps 1, 5, and 6. Regarding step 6, it must be mentioned that serious trouble can result if the reaction product is not a gas, i.e., if it is a condensed phase. Discharge of the cell then results in blocking of the pores by the liquid (or solid) phase and further reaction is impossible. Certain hydrogen–oxygen cells suffer from this limitation.

Chemisorption can be enhanced by selection of electrode material for its catalytic properties or otherwise including catalysts in the pores. For example, a porous carbon electrode may be made into a good hydrogen electrode by dispersing throughout the electrode finely divided platinum metal. This provides the surface on which the hydrogen can be chemisorbed as hydrogen atoms.

The path by which the chemisorbed atom reacts with the ionic species in the elecrolyte is a subject of much conjecture, and is an area in which a great deal more fundamental research is needed. Some of the possibilities are illustrated in Figs. 3 and 4. However, the pertinent experiments to decide between the mechanisms have not yet been done. It is believed that hydrogen reacting at a nickel electrode in aqueous caustic follows a path similar to that suggested in Fig. 3. Virtually nothing is known of the behavior of carbon monoxide at an electrode. A possible reaction path for oxygen reacting at an electrode in caustic electrolyte is shown in Fig. 4.

The selection of an electrolyte for a fuel cell is restricted by the requirement of invariance. This requirement is simply that the electrolyte must not change in composition or amount with cell operation. Ions consumed at one electrode must be replaced by reactions at the opposite electrode.

Other Systems. In the foregoing paragraphs, we have indicated that there are considerable difficulties involved in the design, construction, and operation of gas-diffusion electrodes. These difficulties have prompted fuel-cell investigators to try other types of electrodes and other approaches to the fuel cell. Two important cases deserve mention. The first applies to high-temperature fuel cells using molten salts as electrolytes. Almost all such fuel cells consist of a disk of porous ceramic saturated with the molten salt. The electrodes consist of screens or disks of porous metal and/or metal oxides contacting the two faces of the disk. This is somewhat analogous to the use of separators in storage batteries. Capillary forces tend to keep the electrolyte in the ceramic and thus prevent "drowning" of the electrodes. While simplifying electrode and cell construction, the use of a ceramic matrix is certain to result in greater internal resistance in the cell. Also, a screen electrode cannot be expected to yield as high a current density as a true gas-diffusion electrode, inasmuch as there is much less active area per unit geometrical area.

A more radical departure from gas electrodes appears in the so-called redox cells. Here an intermediate substance in aqueous solution is reduced by the fuel and is then circulated over an inert electrode (anode) where it is oxidized, releasing electrons to the electrode. Similarly, an intermediate oxidant is oxidized by oxygen and circulated to an inert cathode and there reduced. Fig. 5 shows a schematic redox cell. Posner in England has reported extensive studies of a redox cell using coal with limited success.[9,10] In 1948, Carson described a study of redox cells based on carbon monoxide.[11] The efficiency of these cells was poor chiefly because of a very low-voltage redox pair. While the electrode problem is solved by the redox approach—large current densities being achieved by suitable electrodes of graphite or nickel—many other difficulties are introduced. Chief

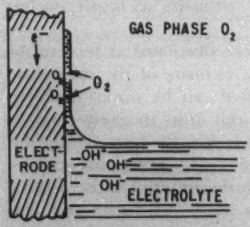

Fig. 4. One suggested reaction path for oxygen at the cathode of a fuel cell: diffusion of gas molecules through adherent electrolyte film.

among these is the problem of finding suitable intermediate redox couples, one readily reduced by a conventional fuel and the other readily oxidized by air, which will yield a high cell voltage.

STATE OF THE ART

Hydrogen–Oxygen Cells. Recent fuel cell development has taken two distinct paths. Efforts in one direction have been toward low-temperature (25–250 C) hydrogen–oxygen cells utilizing gas-diffusion electrodes. When operated with pure hydrogen and oxygen under pressure, these cells are characterized by very high specific power output. The most highly developed is the Bacon cell, invented by F. T. Bacon in England and being marketed in this country by the Patterson-Moos Division of the Universal Winding Company.[4] In this cell, the operating temperature is 200–240 C, which entails pressurizing the gases to 600–800 psi. Plaques of porous nickel serve as electrodes. About 6 mm thick, they contain pores averaging 30 microns in diameter on the gas side and 16 microns on the electrolyte side. Fig. 6 shows a schematic diagram of the cell and Table II gives some performance figures. Certainly, the Bacon cell is the most compact of the power sources. The very large current densities are to be attributed in part to the high pressure. Among the principal limitations must be mentioned the necessity for very pure hydrogen and the short life of the oxygen electrode. Regarding the latter, 1,500-hour runs have been achieved.

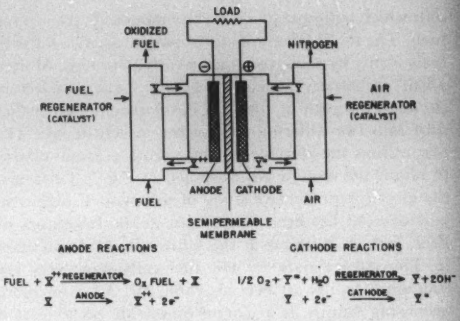

Fig. 5. Schematic diagram of a redox fuel cell.

Table II. Performance of the Bacon Cell*

Current Density, amperes per square foot	Voltage, volts	Power Density, watts per square foot	Free Energy Efficiency,† per cent	Thermal Efficiency,‡ per cent
9.3	1.02	9.5	85	76
93	0.905	84	75	67
233	0.805	188	66	59
466	0.677	316	57	51
632	0.585	370	48	43

* Temperature, 200 C; Pressure, 600 psi.
† Based on $\triangle G$ at operating temperature.
‡ Based on $\triangle H$ of hydrogen combustion to gaseous water at temperature.

Table III. Performance of the National Carbon Fuel Cell*

Current Density, amperes per square foot	Voltage, volts	Power Density, watts per square foot	Free Energy Efficiency,† per cent
10	0.93	9.3	76
30	0.87	26	71
75	0.78	58.5	63
100	0.72	72	59

* Temperature, 60–65 C; Pressure, 150 psi.
† Based on $\triangle G$ at operating temperature.

Table IV. Performance of High-Temperature Carbon Monoxide–Air Cell Using Molten Alkali Carbonates in MgO Matrix*

Current Density, amperes per square foot	Voltage, volts	Power Density, watts per square foot	Free Energy Efficiency,† per cent	Total Efficiency,‡ per cent
10	0.79	7.9	77	75
20	0.75	15	73	66
30	0.65	19.5	63	58
40	0.60	24	58	52

* Temperature, 720 C; Pressure, 1 atmosphere; Anode, iron; Cathode, silver.
† Based on $\triangle G$ at the operating temperature.
‡ An over-all efficiency defined by Broers for integrated plant in which combustion product is recycled over coal.[16]
Note: These figures were supplied by Ketelaar & Broers.

Table V. Performance of Carbon Monoxide–Oxygen Cell with Gas-Diffusion Electrodes in Molten Alkali Carbonates*

Current Density, amperes per square foot	Voltage, volts	Power Density, watts per square foot	Free Energy Efficiency, per cent
5	0.93	4.6	89
10	0.83	8.3	80
15	0.70	10.5	67
20	0.50	10.0	48

* Temperature, 600 C; Pressure, 1 atmosphere.
Note: These figures were supplied by General Electric Company Research Laboratory.

Table VI. Performance of Hydrogen–Oxygen Cell with Gas-Diffusion Electrodes in Molten Alkali Carbonates*

Current Density, amperes per square foot	Voltage, volts	Power Density, watts per square foot	Free Energy Efficiency, per cent
5	1.13	5.7	98
10	1.03	10.3	89
15	0.93	13.0	81
20	0.82	16.4	71
30	0.60	18	52

* Temperature, 600 C; Pressure, 1 atmosphere.
Note: These figures were supplied by General Electric Company Research Laboratory.

High-Temperature Cells. Our earlier considerations on fuel economics indicate the direction of the other path of fuel cell development, toward high-temperature

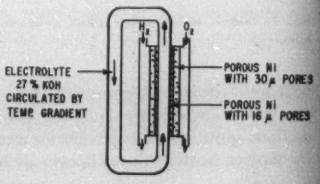

Fig. 6. Section through hydrogen–oxygen cell of type developed by F. T. Bacon. View is schematic and does not show auxiliary pressure and flow system.

cells which will operate on carbon monoxide containing fuels. The requirement of electrolyte invariance for such fuels is met by those containing carbonate ions. Molten alkali carbonates appear to be the most satisfactory choice. This path of fuel cell development has further split into two differing approaches to cell design. The first utilizes the aforementioned porous ceramic matrix to retain the molten salt as shown in Fig. 7. Certainly, the most comprehensive study of this type of high-temperature cell has been carried out in the laboratory of Prof. J. A. A. Ketelaar at the University of Amsterdam in The Netherlands.[13,14] His fuel cells show very encouraging results as seen in Table IV. An even more promising feature is a demonstrated life of at least 6 months at 650 C.

The second approach to the design of high-temperature molten carbonate cells is to use gas-diffusion electrodes in the free liquid electrolyte. At the Research Laboratory, the possibilities along these lines have been investigated. Fig. 8 shows an apparatus for testing various designs of gas-diffusion electrodes. Some typical results are given in Tables V and VI. Progress to date has been encouraging but not spectacular in these cells, which are designed for convenience in testing electrode materials and structures rather than maximum output. We believe that gas-diffusion electrodes in the molten salt offer the best possibility of obtaining the 100–200 amperes per square foot required for a practical cell.

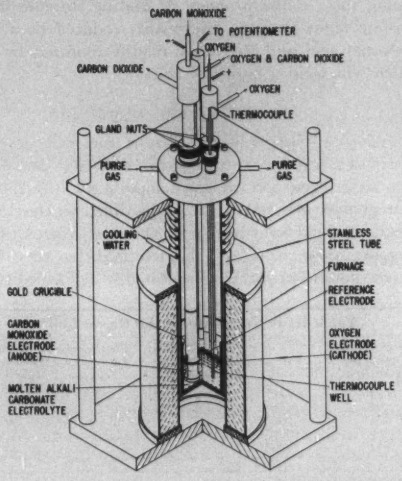

Fig. 8. Isometric view of apparatus used to study the behavior of gas-diffusion electrodes in molten alkali carbonates.

CONCLUSIONS

In closing, a few words about the future are in order. It seems quite safe to predict that the next year or so will see hydrogen–oxygen cells, based on gas-diffusion electrodes, in military and, somewhat later, in some civilian applications. Fuel cells for central station power lie farther in the future; these will burn gaseous fuels containing carbon monoxide and, I believe, will be based also on gas-diffusion electrodes.

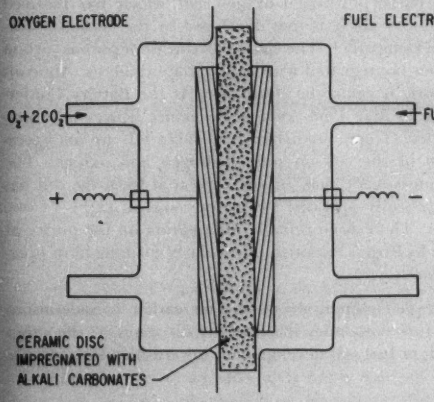

Fig. 7. Ceramic matrix–molten alkali carbonate fuel cell in schematic form.

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Dynamic Response of Arcs in Various Gases

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THE ELECTRICAL characteristics of an arc drawn upon separating the contacts of a circuit interrupter can be classified as the static, or steady-state, and the dynamic characteristic. Both are involved in the circuit interrupting process, but of the two the dynamic characteristic is generally most important. The latter is essentially involved in the transition of the arc from a conductor to an insulator which must precede the recovery of high dielectric strength between the switch contacts. This transition, which depends on changes in energy content associated with the arc conductance, can most conveniently be described and analyzed in terms of differential equations which serve as approximate mathematical "models" of the arc. By means of such models, the arc can be treated as an element in the connected circuit. Usefully simple mathematical models have been devised by several authors by this method, all of which include a characteristic "time constant" which will be designated as θ. This quantity is a measure of the time required for the arc conductance to reach a new steady state when its original state is disturbed.

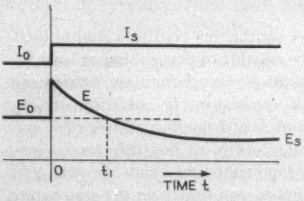

Fig. 1. Plot of model response to current step.

Although the proper use of the models in explaining breaker behavior has not yet been firmly established, the critical terms in possible equations for interrupting limits generally involve the arc time constant θ and the arc voltage. For this reason it was decided to attempt direct measurement of arc time constants with the simplest case of low-current d-c arcs in various gases under plain break conditions. Results with relatively low current should be useful because the critical phenomena for extinction of high-current a-c arcs occur within a small time region near the passage of the current through zero when the instantaneous current values are low.

In measuring the arc time constants, a simple step current modulation was applied based on equations 1 and 2 derived from the mathematical model devised by O. Mayr.

$$\frac{E}{E_o} = \frac{E_s/E_o}{1+\left(\frac{E_s}{E_o}\,\frac{I_o}{I_s}-1\right)\epsilon^{-t/\theta}} \qquad (1)$$

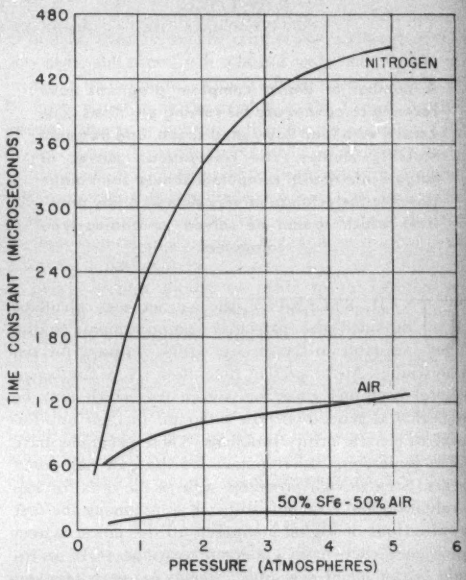

Fig. 2. Arc time constants vs pressure in N_2, air, and 50% SF_6–50% air. One-ampere vertical arc, one-inch contact separation, and 9/16-inch enclosing cage.

$$\theta = \frac{t_1}{ln\,\frac{E_o/E_s - I_o/I_s}{E_o/E_s - 1}} \qquad (2)$$

As illustrated in Fig. 1, the steady current I_o was changed to a new steady current I_s abruptly at $t = 0$, and from the observed arc voltage response t_1, E_o, and E_s were measured. From these measured values θ was calculated from equation 2.

The arc time constant measurements were made with current magnitudes from about 1 ampere to 6 amperes and pressures from 1/4 to 7 atmospheres in the gases: SF_6, air, N_2, CO_2, He, ClO_3F, O_2 and the mixtures of SF_6 and air or N_2. The measured arc time constants varied widely between different gases, increased with pressure, and also increased with current. Fig. 2 illustrates some of our results. With pure SF_6, time constants as short as 0.25 microsecond were found at 0.5 atmosphere pressure.

Digest of paper 58-1220, recommended by the AIEE Switchgear Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Pittsburgh, Pa., Oct. 26-31, 1958. Published in AIEE *Power Apparatus and Systems*, Feb. 1959.

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Digital Computer Programs in Electric Utilities

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A number of digital computer programs have recently come into use for solving problems concerned with load flow, short circuit, and transient stability studies. The tremendous power of large-scale digital computers should soon make possible the solution of very difficult utility problems which cannot be solved on analog-type computers.

UNTIL RECENTLY, the a-c network calculator provided the principal computational facility available to the electric utility industry for system studies. At the present time, however, a number of digital computer programs are in use which may be regarded as general-purpose programs in their application to electric utility problems. These programs have been undergoing development for the past half-dozen years. Even though programs such as the ones for loss evaluation and economic dispatch were among the first applications of digital computers to the power system problems, they have undergone various revisions to take advantage of new advancements in computers and improved techniques. Experience has indicated that this revision of programs is a continuing process and few, if any, of the programs, as they are written today, will prove to be entirely suitable in the near future.

The inclusion of the digital computer as a tool for the electric utility industry has opened up enormous fields for application and development. We have been used to thinking of computers as being applied solely to network problems, for example, those associated with the network calculator, but we may now apply the computer to the many facets of economics and design problems. Digital computers have already been extensively used in the design of transformers and rotating machinery, and promise to enjoy wide application in solution of future design problems.[1,2,3] In the economics area, the application of computers for the solution of distribution system voltage control[4] has been undertaken along with the investigation of an economic evaluation of costs of alternate plans for system expansion.

The more recent general-purpose programs are those used for solving the problems concerned with load flow, short circuit, and transient stability studies. It is these problems on which the authors wish to place particular emphasis, because the previously available literature has described those programs which have been in use over a longer period of time.

Full text of District conference paper DP59-655, presented at the AIEE Middle Eastern District Meeting, Baltimore, Md., May 19-21, 1959, at a session sponsored by the AIEE Computing Devices Committee.

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POWER SYSTEM LOAD-FLOW STUDIES

THE POWER SYSTEM load-flow study is one of the most important single problems of power system analysis. Basically, this problem consists of finding the flow of power and vars through the power systems as a function of certain terminal constraints, such as power and var requirements of the load busses, dispatched power from all of the generators (except the swing machine), and bus voltages at certain key points throughout the power system.

In order to achieve satisfactory results, a digital load-flow program must be capable of performing at least the same type of operations as were heretofore carried out on the a-c network calculator. In addition to the straightforward type of board manipulations, such special features as remote control of bus voltages by generators, automatic tap changing under load, and maximum and minimum var limits on generators are included.

At the present time, there are several different load-flow programs in use throughout the country and although they all use the same basic method (the solution of nodal equations[5]), the programs vary somewhat by the manner in which they operate on this method, their flexibility in handling input and output data, the availability of special automatic features, etc. The following specific comments present some picture of what one could expect as output and special features available in a digital load-flow program:

Output

1. A complete set of terminal conditions at every bus in the system is printed. This includes generator megavars and angle where generator megawatts and voltage have been specified, and voltage and angle where load megawatts and megavars have been specified. Special combinations of these are also available, and will be discussed presently.
2. Also printed is the complete line-flow data, including megawatt and megavar flow for every branch in the system. This includes I^2R and megavar losses in all lines and the total I^2R and megavar losses in the system. In addition, where automatic tap changing under load is used, the final position of all tap changers necessary to hold the desired condition is given.

3. A print-out of the rectangular components of bus voltages and load currents, for possible use with loss formula calculation, is available.

Features

1. Accuracy criterion is at the discretion of the user, inasmuch as the inherent precision of digital computers allows as fine a solution as is desired. The program determines the mismatch, or residual megawatts and megavars, at each bus in the system, these residuals always being smaller than the accuracy criterion.

2. All final angles may be referenced to any value, at any bus.

3. One can specify automatic tap changing under load, with the program selecting the optimum tap position necessary to hold desired conditions.

4. Phase-shifting transformers can be used where desired.

5. Megavar limits may be set on any or all generators in the system, including the swing machine.

6. Remote bus voltage can be controlled by a generator located at some other bus.

7. Consecutive cases, in which specified branches are changed or generation and loads are varied (or both), can be selected automatically.

These features are in addition to the program accepting the usual power system components of simple transmission lines, π lines, fixed shunt capacitors and reactors, fixed transformer branches, synchronous condensers, and similar devices as input data.

The digital load flow requires the same system data as that needed for the network calculator study. Although it may appear that the digital input data requires a more precise definition of the problem, this same data would be necessary to conduct a board study properly. The main difference is that the digital solution requires all of this information before beginning the problem, whereas on a board study some of this information is supplied piecemeal during the course of the study when particular situations arise.

In specifying the system parameters and conditions, it is well to keep in mind the following facts because they will bear on the cost of the study:

1. Those features which require the computer to check certain conditions and possibly make adjustments should be kept to a necessary minimum. Although these checks and adjustments require only a short time, they must be done many times during a single study; hence, they do have some noticeable effect on the calculation time. These features would include tap changing under load, holding voltage on a bus with a generator connected to some remote bus, and var limits on generators. An example of an excessive use of these features would be to specify var limits on all generators, knowing that many specific ones would never reach either limit or would always be at one of the limits.

2. The accuracy of the solution should never be specified arbitrarily. The accuracy criteria should be relaxed as much as can be tolerated. If certain specific cases require more accuracy than others then different criterias should be specified for the different cases. Computing time drops off quite rapidly as the criteria is relaxed.

3. The acceleration constant used for the real and imaginary part of the voltage correction should be investigated. Although the range from 1.5 to 1.8 appears to be best, these values are critical and a change of 0.1 may cause the time for a solution to be modified by a factor of two or more. This is an area which needs to be investigated more thoroughly in the future. At the present time it is indicated that for an optimum calculation time, these constants should be varied for each system configuration even when the change in configuration represents only a single line out. This is not very practical, however, and at the present state of the art the best method appears to be to find a good set of constants for a basic system.

4. Every attempt should be made to run studies in groups of four or more. Since there is usually some set-up time associated with each computer run, this time must be spread out over the number of studies run in a group.

In summary, it can be said that although the digital load-flow solution is generally an economical solution, additional savings can be realized by giving proper consideration to certain optimizing factors.

SHORT-CIRCUIT STUDIES

THE DETERMINATION of the behavior of large electric networks confronts the engineer or mathematician with the necessity for solving a large number of equilibrium equations determined by the network and the restraints placed on it. For the most part, those engaged in this work have relied on nodal analysis methods because of the relative ease of establishing network relationships in the computer from basic topological and impedance data.

However, it was the desire in the case of the short-circuit study to use the equilibrium equations obtained with mesh analysis. This method often will not only reduce the number of equations, but also ease the handling of mutual inductive coupling.

To accomplish this end, it was necessary to explore the possibility of forming mesh-current relationships from raw system data by use of a large-scale digital computer. The heart of this matter was concerned with the generation of a matrix, called a transformation or T matrix, which contains in usable form the information regarding network configuration which is needed to establish the required number of independent equations.[6]

With this matrix, a table of branch impedances, and a table of mutual inductances, the computer calculates the coefficients of the necessary equilibrium equations in mesh form. This provides a fundamental basis for the short-circuit study and also has been used to facilitate the calculation of the self- and mutual-drop coeffi-

cients used in the development of a power-loss formula. Further, it would be possible to use these equations as a basis for obtaining various system equivalents which may be used throughout a power system analysis. These applications, as well as others, have fostered a feeling among the authors that an entirely new avenue of approach has been opened up by the automatic formation of the T matrix and the relevant equilibrium equations by means of a computer.

In particular, we will now turn our attention to the short-circuit study. Most short-circuit studies are conducted with one of two objectives in mind. Symmetrical 3-phase faults may be applied to systems to determine breaker ratings, or single line-to-ground fault studies may be made to determine zero-sequence relay settings. In general, a considerable amount of data is acquired in the course of doing a complete fault study because so many various fault conditions are possible on the system. Faults are generally applied for every bus in the system with the system normal and with the various lines to each bus removed one at a time. For the purposes of relay coordination, line-end faults are also studied. This is a condition where a fault exists on a line at one end or the other with the breaker between the fault point and the adjacent bus open.

This type of study undertaken on the digital computer is a formidable one, principally because of the many changing network configurations resulting from the removal of lines completely or their partial removal during a line-end fault.

A detailed description of the procedures and program for solving short circuits can be found in a 1958 paper.[7] The digital program reported there calculates network voltages and currents for either 3-phase or single-phase line-to-ground faults. The calculation is essentially the same as that normally made on the a-c network calculator. A network, consisting of the transmission system and shunt impedances representing generators and contributing loads, is energized by a single source applied at the fault point. The resulting currents and voltages are calculated along with the driving-point impedance from fault node to neutral. Provision is made for calculating faults on the line terminals of an open circuit breaker (called line-end faults) and for calculating faults following the removal of lines as with scheduled line outages. Inductive mutual coupling is properly considered. Several significant features of the methods described should be noted at the outset:

1. Mesh analysis is used to establish the equilibrium equations for the network. The equations are obtained in the computer automatically from a tabulation of impedances and connections. General network configurations are admissible.
2. The currents in the network are obtained by inverting the coefficient matrix for a set of loop-current equations and multiplying appropriate forcing-function vectors by this inverse.
3. The effect of the changing network configuration due to the removal of a line or a line-end fault is accomplished by changing the forcing function. This is no more than the application of the superposition theorem. The number of loop equations is not altered, nor are the coefficients of these equations altered.
4. Similarly, the effect of moving the fault from bus to bus in the system is accomplished by changing the forcing function. Thus, only one matrix inversion is required to obtain results for all fault locations, all line-end faults, and all line-outage schedules.
5. The automatic calculation of fault currents and voltages relies on the formation and use in the computer of the T matrix, previously mentioned, by which the machine is able to relate the individual branch currents to the network loop currents. This matrix also enables the computer to know which of the branches combine to form the various loops in the network, and it thus allows the calculation of node voltages through appropriate combinations of branch voltages.

It may be argued that considerable refinement of fault calculations is possible with a large-scale computer over what is presently done on the network calculator. The work described in the papers cited was guided, however, by the thought that present a-c board techniques provide results which are adequate in a very large percentage of studies. Therefore, efforts should be directed toward writing a program which would provide these same results to the user with the inherent advantages of error-free calculation on a computer which is available on very short notice.

Specifically, the program which is available is quite flexible and allows the user to indicate several choices depending upon the type of study.

1. Current choices:
   a. Do not print currents
   b. Print all currents in the system
   c. Print currents only around the faulted node
   d. Print currents around designated nodes
2. Voltage choices:
   a. Do not print voltages
   b. Print all the node voltages
3. Removal-of-lines choices:
   a. Do not remove lines
   b. Remove all lines at each faulted node, one at a time
   c. Remove designated lines (anywhere in the system) one at a time for each faulted node

Because a great deal of data is obtained in the form of results from the barest of input data, the foregoing choices are quite meaningful, as half the computer time may well be spent just in printing the results onto an output tape.

In the following tabulation, a solution is defined as the calculation of the desired currents and voltages when a fault is applied at a bus with no lines removed, or at a bus with some line removed, or as a fault applied at the end of a line.

Number of Nodes	Number of Lines	Number of Solutions	Time if All Currents and Voltages Are Computed, Minutes	Printing Time, Minutes
26	43	170	20	12
26	43	70	8.5	5

In addition, it may be remarked that for these problems it took 38 seconds of machine time to do the equivalent of plugging the a-c board, i.e., finding the T matrix and setting up the equations.

TRANSIENT STABILITY STUDIES

TRANSIENT STABILITY STUDIES are undertaken to determine how the phase positions of the generators in a power system vary relative to each other following a severe system disturbance, such as a fault.

As is true for most of the electric utility problems, the basic concepts and underlying techniques have long been associated with studies on the a-c calculating board. However, a great deal of work towards automatizing this problem has been carried out and reported on by various authors.[8-10] The principal objective has been to begin with the rawest of input data and proceed through the calculation of swing-curve data without manual intervention.

The particular program available through the analytical department of Westinghouse Electric Corporation assumes that a load-flow study has been made to determine the initial steady-state condition of the system. The input data for this program includes the normal system parameters, such as line and transformer impedances, tap setting and line charging; generator terminal conditions; and voltages P and Q at the load busses. In addition, the program requires the various pieces of data connected with the actual swing calculation such as the fault location, the time intervals, switching procedures, and H constants. Thus, the digital method requires the same data as one would need for the analog method.

A considerable portion of any program for solving the transient stability problem must be given to the calculation of the accelerating powers. These powers may be obtained by various methods. One of the more popular ways is to use a load-flow program to calculate the powers at each step. This method has produced favorable results but it was the belief of the authors that if a method providing a network reduction were devised, the time of calculation could be speeded up considerably, thus reducing the cost per study.

The method of network reduction consists of reducing a system containing generator busses, fault busses, and load busses, to an equivalent system where only the busses behind generator transient reactance are retained.

Originally, this system reduction was accomplished by means of matrix partitioning. This method was quite successful for small systems, but the matrix operations for larger systems proved to be too lengthy. There was also a serious size limitation in that the number of load points could not exceed 50.

A second look at this problem has definitely shown that if the network reduction is accomplished by eliminating a bus at a time, that is, the matrix is reduced by one column and row, the entire process goes much more rapidly. This method not only speeds up the reduction time, but also permits the program to accommodate a much larger system by taking advantage of the many zero elements present.

As in all reduction methods, it is necessary to obtain a matrix for each network change which results from the application of faults and breaker operations. To do this efficiently, the load busses are eliminated only once and the resulting matrix is then reduced several times, with each reduction preceded by an alteration to the matrix to account for the faults and various switching operations. For a system of 150 busses, the time required to obtain the reductions for five different system configurations should be about 1 minute.

After these matrices have been obtained, the data for the swing curves are calculated using a modified Euler method. These results are printed as a tabulation of angle vs time.

In summary, the digital transient stability program not only appears to be economical, but also eliminates the many tedious hand calculations associated with the analog method.

ECONOMIC PROBLEMS

PERHAPS one of the earliest large-scale uses of the digital computer for power system problems is in the general field of economic dispatch of system generation, and the closely allied problem of the development of power system loss formulas.

The details of the analysis of these problems are by now familiar and are thoroughly covered in the literature.[11,12] Briefly, loss formulas are found by combining information from an amplified load-flow study with a description of the system in terms of self- and mutual-drop coefficients.

The program for the IBM (International Business Machines) *704* digital computer used by the analytical department combines the determination of the loss formula from the base case quantities (voltage framework and load-current ratios), assumed variation of reactive power, and self- and mutual-drop coefficients with the evaluation of the loss formula for a number of check cases. The computer time required for this program depends on the size of the system and the number of check cases and ranges from 5 to 10 minutes for typical systems. The per-cent difference between the calculated and measured system losses is calculated by the program for each check case. This allows rapid evaluation of a proposed loss formula. This feature, coupled with the relatively short computer running time, makes possible the development of loss formulas for a number of different relationships of reactive power to real power, and thereby allows careful study of methods for improving the accuracy of a proposed loss formula.

Another program that has been used for a number of electric utility customers is the one to obtain the economic dispatch of generation once the station incremental fuel rates, system loss formula, and loading of the fixed stations, tie lines, and nonconforming loads are known. In general, the machine time is proportional to the number of points of entry into the system, that is, the number of generation stations, tie lines, and nonconforming loads represented in the loss formula. Naturally, the machine time required is also proportional to the number of dispatches at specific values of load power or total generation that are desired. In general, a complete set of dispatch curves showing the value of power at each generating station as a function of total system load or total system generation will require 15 to 25 such points. Using our present program, approximately 30 station points can be calculated per minute. This means that the dispatch for one value of total load power or total generation for a system with 30 points of entry will require approximately 1 minute of machine time. These time figures are based on a standard problem and do not allow for special features such as special handling of hydroelectric generation as a function of system load.

The worth of these two programs has been well proved by the repetitive use made of them. New programs dealing with system economics have been written recently and still newer ones are in the process of being written. The next few years should show this to be a fruitful area for investigation.

AVAILABILITY OF DIGITAL COMPUTER SERVICE

A SERVICE, based on the electric utility programs which have been developed at Westinghouse, is available using the analytical department *704* computer in the same manner as the a-c network calculator service. A feature of this service which is particularly attractive to many utilities is the possibility of having problems solved through a mail-order service. This has worked out quite well, especially in those cases where the users were present to follow the solution of a given type of problem before attempting to use mail-order service.

Until a short time ago, the various program decks were not generally made available outside of the company which initiated the program. There were two basic reasons for this. First, knowledge of computer operations and techniques was not as widespread as it is at present. Second, most computer programs are being continually modified to keep them up to date. Thus, a program made available one month could be replaced with a faster and more flexible program the next month. The necessary work involved in preparing for a program release could delay the actual release by many months from the time when the program would be available for use on a service bureau basis.

The first of these two objections to the release of programs has been partially wiped out at present and, since this was one of the main objections, several programs have been made available for general use. However, it would be well to keep in mind that programs are being continually changed and use of the program on a service bureau basis should be considered.

If the decision is made to use the available programs away from the original programming location, it would be advisable to conduct at least one study of the type in conjunction with the sponsors of the program.

CONCLUSIONS

AT THE PRESENT TIME, the application of digital computers to electric utility problems has been, with the exception of the loss evaluation problem, in obtaining solutions to problems which were already being solved on another computational facility. We have learned a great deal from the development and application of these programs to power system network problems. It should be emphasized, however, that the application to power system problems is still a subject in its infancy and that we have only taken the first steps in applying this powerful tool to electric utility problems. The tremendous power of large-scale digital computers will permit the solution, in the near future, of very difficult engineering problems growing out of utility operations and planning, subject to economic and practical constraints, which could not previously be solved on analog-type computers. The service thus provided to the electric utility industry will continue to grow and expand as new and more difficult problems become solvable with newer techniques and more advanced computers.

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Reversible Polarity D-C Power Amplifier

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MAJOR PROBLEMS in devising reversible polarity direct current magnetic amplifiers are poor efficiency and large voltage regulation. Conventional reversible polarity circuits have a maximum theoretical efficiency of 50 per cent as compared to 100 per cent for the circuit under consideration. The increase in efficiency is accomplished by using switched transistors in conjunction with magnetic amplifiers. Previous applications of switched transistors have had magnetic amplifier gate windings in series with the transistors. Such circuits have the disadvantage of requiring the use of power magnetic amplifiers.

The advantages of operating transistors in their switching mode as controlled rectifiers include reduced losses and temperature rise. Since the output of a self-saturating magnetic amplifier is a switched form of sine wave, it is well suited for control of transistors in their switching mode. In such a scheme the transistors control the load power while the magnetic amplifier output power need only be sufficient to control the transistors. The use of switching transistors controlled by magnetic amplifiers has the important advantage of isolated, multiple input windings.

Fig. 1 is a schematic representation of the basic circuit for providing reversible polarity direct current for a two-terminal load. The magnetic amplifiers are designed for d-c output and are biased to cutoff. Ideally, there is no base drive in the transistors under quiescent conditions and both transistors are nonconducting. In actual operation, however, the exciting current required by the magnetic amplifier cores at cutoff prevents this condition from being realized completely. Failure to render both transistors nonconducting under quiescent conditions results in an undesirably large circulating current and a balancing problem. This effect can be minimized by use of shunting resistors in the base drive circuit either separately or in combination with a balancing circuit. Inasmuch as the transistors are switched either fully off or fully on, there is no gain balancing problem associated with the use of the transistors.

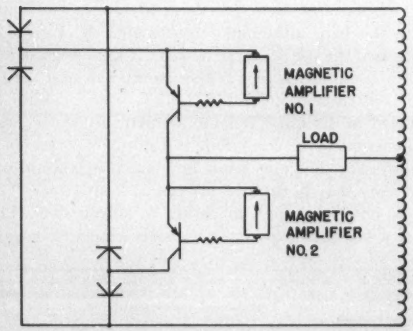

Fig. 1. Basic circuit for reversible polarity d-c power amplifier.

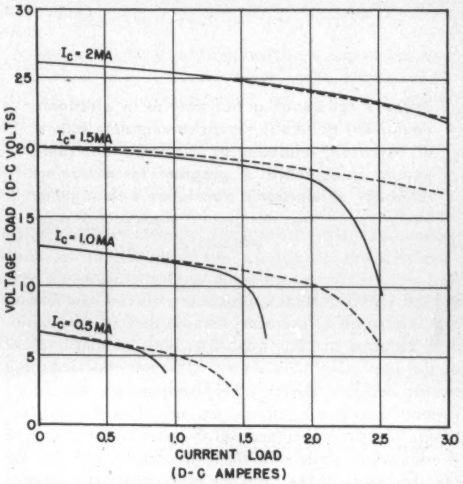

Fig. 2. Voltage regulation for fixed magnetic amplifier control currents. Solid lines—large base circuit resistance. Dashed lines—small base circuit resistance.

Fig. 2 shows the effect of base current level upon voltage regulation. The sharp dropoff appearing in the solid curves results from the transistor's being driven out of its switching mode as load current is increased. This effect can be minimized (shown by the dashed curves) by reducing the base circuit resistance and, thereby, increasing the base drive. Dropoff is still apparent at late firing angles (small control currents) because of the high peak currents required for a given average value of current.

Experimental results indicate that voltage regulation of the order of 10 per cent is obtainable at full output. At reduced output, the regulation is somewhat increased. Efficiencies of the order of 70 per cent are readily obtainable by using switched transistors or rectifiers controlled by magnetic amplifiers.

Digest of paper 58-1177, "Reversible Polarity D-C Power Amplifier Using Magnetic Amplifier Controlled Switched Transistors," recommended by the AIEE Magnetic Amplifiers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Pittsburgh, Pa., Oct. 26-31, 1958. Published in AIEE *Communication and Electronics*, Jan. 1959.

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Reliability of Transformers for Electronic Applications

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Because failure of a transformer in electronic equipment generally results in complete failure of its circuit, reliability of this important component is essential. A program for achieving reliability of electronic transformers throughout every step of their design and production is proposed.

TRANSFORMERS constitute a special case among electronic components because they are not manufactured in large quantities with standard values of the important parameters. Although the electronic system designer *selects* other components, the transformers usually are custom *designed*. Co-operation between the system designer and the transformer engineer is essential in order that the best transformers may be obtained to meet the need for ever-smaller size, lighter weight, and increased reliability in ever more severe environments. Although transformers are the most reliable electronic component,[1] if a transformer does fail it is likely to mean the complete failure of the circuit employing it rather than a mere degradation in performance; thus, its reliability cannot be taken for granted. Extremely reliable transformers can be produced only by a program aiming at reliability in every step of the transformers' design and production. In this article, a program of this nature is proposed.

SPECIFICATION REQUIREMENTS

BEFORE a transformer can be designed, the requirements of the application must be specified by the equipment designer. The misapplication of components such as transformers has been shown to be a major cause of failure in service.[2] In commercial applications, many requirements may be left unspecified to be covered by "good engineering practice," which, of course, depends upon the transformer designer's prior understanding of the application. Military requirements are similarly considered to be covered by specification MIL-T-27A, Transformers and Inductors (Audio, Power and Pulse). However, MIL-T-27A leaves many requirements to be specified. In addition, many others should be revised to suit particular applications.

The actual needs for the application should be determined carefully. The life of a transformer depends not linearly, but exponentially, upon the severity of environmental stress.[3] That is to say, for example, that for every 25 C increase in the operating temperature, the life reduces to about one tenth of its former value (up to some point where an increase in the temperature may reach a critical point for some material in the transformer and the life drops to zero). If environmental requirements are set too low in the specification, a transformer meeting these requirements may have *no* reliability when subjected to the higher stresses of actual use.

Overspecification is also dangerous. Insistence on high operating temperatures leads to the use of the newer, less well-proved insulating materials. At such temperatures, W. I. Bull[4] suggests, ". . . we have not yet reached the point we can indulge in a discussion of reliability . . . we must first obtain some real degree of performance at these temperatures." Even Class B temperatures force the use of insulating materials which are less satisfactory mechanically and not available in as wide a range of sizes as Class A materials. Such materials limit the construction methods and even in some cases the minimum size. This suggests that the life can be overspecified, too. For example, Class A insulation is highly reliable at Class B temperatures for a few thousand hours, if it is potted or otherwise protected from oxygen.

Insistence upon smaller size puts reliability into hazard. It leads to finer wire more easily damaged by both electrolytic corrosion and by mechanical stresses. It tends to encourage use of bobbin windings rather than the more reliable layer-insulated windings. It results in hotter transformers and shorter life, or use of the less well-proved high-temperature materials.

DESIGN

TRANSFORMER DESIGNERS must, of course, aim higher than the bare minimum requirements. R. Lusser has suggested the use of safety factors for the design of electronic components in a fashion similar to that used in the construction industry.[5] This is what actually has evolved in the quite reliable hermetically sealed, moderate-temperature nonmobile transformers. Experienced transformer designers know how much maximum voltage stress may be applied per mil of kraft paper. They know how much flux to permit in silicon steel. They have a wealth of experience with the temperature–aging

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characteristics of Class A insulation. They are quite familiar with the dielectric properties of insulating oils. What is missing is a standard for the values of such properties corresponding to the accepted charts of strengths of construction materials, and a set of safety factors corresponding to those of the construction industry.

Examination of the more conventional transformers shows that there is good agreement among designers in the end result. It should not be too hard to gain acceptance for a standard set of design values for the materials. There will be more of a problem to set such values for the newer materials, but the use of larger safety factors with such materials should make this less hazardous.

To paraphrase J. M. Bridges,[6] we need "a design specification which will make it mandatory that certain design practices and philosophies, known to be essential to reliability, are included in the development."

While this suggestion will be criticized as too-severely restricting the designer, it may be pointed out that we are concerned here only with those transformers which must be of the highest reliability. A designer who chooses to experiment with new materials or techniques can still prove them in by test, but until they are proved, they must be considered less reliable. It is also worth pondering that the construction industry, with safety factors and building codes, is still very competitive. Apparently its designers are not restricted so as to prevent competition!

It is to be hoped that such standards for electronic transformers will be set by the transformer designers and not imposed by the customers. On the other hand, if such standards are to be successful, the customers must not buy below-standard products because they are cheaper, smaller, or lighter, regardless of reliability.

QUALIFICATION TESTING

QUALIFICATION TESTING, as well as establishing that the transformer design performs according to specification under static conditions in simulated environments in the laboratory, should include tests of samples to failure under the specified environmental conditions.[5,7] This should be done to establish the failure points rather than to prove only that the design meets specification requirements. There must be a pattern of failure which establishes that there *is* a factor of safety over the specification, as shown in Fig. 1. Thus, samples must be vibrated, shocked, run at high altitude and extremes of temperature, and subjected to combinations of such stresses to determine at what points failure occurs.

The causes of failure should be determined especially in the case of combined stresses since such failures may expose weak points, and the need for still further tests may be suggested. It may often prove difficult to pin down these causes.

R. Lusser has pointed out that the number of samples needed to determine a failure pattern to a sufficient precision is quite small, in contrast to the very large number necessary to prove that a design meets specified limits.[5] For example, two dozen samples might give a very good idea of the failure pattern if tested to destruction. But if testing is to specified limits, to prove with 90% confidence that the failure rate is one in 10,000 requires 100,000 samples! It is notable that most qualification testing to specification limits is statistically invalid because of the few samples used.

RE-EXAMINATION OF APPLICATION

AS SUGGESTED by J. A. Connor,[8] the components' environmental conditions are never really known until after the prototype equipment is put together. It is important that the specification requirements be checked against the actual conditions as soon as possible. Because of the flexibility of the structure, the vibration of the transformer may be either less or more than that of the equipment as a whole. Ambient temperatures, particularly at high altitude, are hard to predict. Changes in the equipment design may change the environment at the transformer by large amounts.

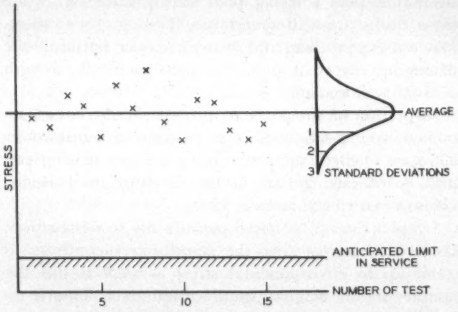

Fig. 1. Proof that failure pattern has safe margin over limit.

It is desirable at this point that the transformer designer be permitted to examine the equipment. He may uncover information not disclosed by the equipment designer, affecting the design or use of the transformer. For example, if the transformer mounting is an effective heat sink and if there is a flow of cooling air, the actual temperature of the transformer in the equipment may be lower than in the still-air test. If the transformer is located near very hot objects such as large vacuum tubes, it may run hotter in the equipment.

PRODUCTION

HIGH-RELIABILITY transformers cannot be made by the same production personnel concerned with lower-grade transformers. The concern over details and the pride of workmanship which should be fostered to get high reliability cannot be maintained if the operators alternate such work with less careful tasks. This argument applies equally, of course, to the engineers and quality control personnel. Each person concerned with any part of the process must be dedicated to reliability.

This is not easy to inspire; we must, as Lusser says,[5] learn to think of reliability as a life-and-death matter as, indeed, in the case of missiles, it may turn out to be.

It is also important to make use of standard procedures to assure uniform quality. No matter how skilled the operators and foremen, reliance must be placed in their following the procedures established as correct, not in their using their own judgment. Operators' ideas may be incorporated in the standard procedure if they prove good ones, but they must not crop up untested in the product. Very often trouble develops after a change in process, even when the change has been tested.

QUALITY CONTROL

ROUTINE TESTING of the electrical characteristics naturally has been important both to the transformer manufacturer and to his customer. But for assuring reliability, inspection of the work in process is much more important. Such inspection can assure that the design requirements are being carried out, and by the correct factory procedures. It can go far in eliminating faulty insulation, poor winding, poor lead splicing, etc., while these faults are still detectable. Testing, by contrast, may not expose them and in itself may be harmful—the damaging effects of repeated high potential strength tests are well known.

Inspection of the work in process should be accompanied by inspection of cross sections of transformers cut open to check the penetration of impregnating varnish, to observe the lay of the windings, to look for voids in cast epoxy, and the like.

Samples should be tested periodically to destruction, also, to determine that the transformers continue to stand up to environmental stress as well as did the samples in the original qualification tests. This is especially important with transformers using the newer materials and methods where more variation may be expected.

The common basis for the customer to evaluate transformers is by limiting per-cent defective found in incoming inspection. While this is of some value,[9] it often becomes concentrated upon minor defects which have little to do with reliability, such as the color of the paint and the completeness of the information marked upon the transformer. The test and inspection records of the transformer manufacturer are much more meaningful and should be open to the examination of the customer. A standard way of keeping such records would help in making them familiar and intelligible to all incoming inspection departments. The "certified test data" covering routine electrical tests is practically worthless. It is more important for the customer to know whether the inspection at the transformer plant shows consistently good quality, or whether the transformers shipped have been culled out of a lot of questionable ones.

FIELD REPORTS

IT IS TO BE HOPED that better reports upon the causes of equipment failure in the field may become available to transformer designers. Lists of transformer failures often turn out to be lists of transformer replacements, with no data which can even assure that the transformers were, in fact, defective. A report on reliability emphasizes that parts "seldom fail without some cause external to their intrinsic properties."[10] Certainly the relation between component reliability and equipment reliability is a complex one involving the environmental stresses and the interaction of various parts upon each other in the equipment.

CONCLUSIONS

HIGH-RELIABILITY TRANSFORMERS can be obtained only if each person concerned with any part of the process is dedicated to reliability. In order to aid the program of each manufacturer, the following industry standards are proposed:

1. Check list of the requirements which must be specified by the equipment designer.
2. Standard design limits and safety factors.
3. Qualification approval methods based upon environmental testing to failure and the proof of a safety factor between the specification limits and the pattern of failure.
4. Inclusion of a review of the specification requirements against the actual equipment as a regular part of new transformer design.
5. Standard quality control records made available by transformer manufacturers to their customers.
6. Improved methods of reporting the causes of field failures.

It is clear that such a program will take time to work out in detail, but if it is tried independently by a number of transformer manufacturers, it will not take long to get some idea of what can be done.

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Remote Automatic Control for Line Capacitors

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STEADILY DECREASING peak-load power factor has amplified the problem of providing a supply for the ever-increasing reactive load on the Baltimore Gas and Electric Company system. The location of new generation in more remote areas has increased the attractiveness of static capacitors located near the load for reactive supply. However, in order to avoid excessive voltage and generator instability at light loads, suitable switching provisions for these capacitors must be available. Capacitors located on substation busses, so as to facilitate this switching, are a step in the right direction, but do not provide relief to the most costly element of the system—the distribution facilities. Pole-mounted line capacitors provide maximum feasible system relief, but the switching must be accomplished by automatic means. Time clocks, voltage, current, temperature, and other types of control are available for this function, and each type has its place. However, the extensive use of these controls presents a substantial co-ordination problem if excessive voltage changes are to be avoided. Considerable maintenance can be expected, and lack of operation supervision would indicate that some routine inspection may be deemed essential.

The use of a reliable remote control would permit the installation of pole-mounted capacitors to the economic limit for system reactive supply and would, in addition, permit control of voltage.

Automatic regulation of substation voltage by use of pole-mounted capacitors would allow the elimination of a considerable portion of the conventional transformer tap-changing-under-load and other voltage-regulating equipment. The voltage rise caused by a bank of capacitors is maximum at the site but has a diminishing effect over the entire system. The cumulative effect of many capacitor banks is to reduce materially the varying voltage gradient over the system with changing loads, hence much less regulating equipment is required.

During 1957, five 4-kv distribution substations on the Baltimore system were equipped with automatic systems for capacitor control which accomplishes these objectives. Control is provided by means of a 60-kc carrier signal transmitted from the substation over the entire 4-kv feeder system radiating from that substation. This carrier is modulated by a multiplicity of tones in the audio range to provide selective switching control over 20 different types, tonewise, of pole-mounted switching receivers. Additional banks above 20 are controlled by pairing two banks. These are located on different feeders so that they may be switched simultaneously without excessive voltage change.

Initiation is obtained by conventional primary relay with compensation, and a bus voltage curve similar to the normal regulated bus is provided. Inasmuch as the voltage gradients of the feeders are far less with control by capacitors, the daily bus voltage curve is much flatter than that of the conventionally regulated bus. Other types of initiation have been used. Switching capacitors as a function of station kilowatt load is satisfactory to compensate for distribution regulation, but requires voltage bias to correct for supply-voltage variations. This bias must be somewhat less than full compensation so as to avoid hunting conditions. Initiation by station net kilovar load, maintaining a deadband centered on zero net kilovars, is being used in those stations where regulating equipment is integral with the transformers, and thermal and loss considerations are paramount. Many other initiation schemes are available to suit local requirements. A switching sequence may be maintained and an overriding timer for early morning hour opening of all capacitors may be provided, hence flexibility for the solution of local problems is also available.

Bank switching operation is supervised at the station by changes on a station net reactive load recorder. Manual switches are provided to permit routine operational checks and manual control during emergency conditions. This control scheme is considered unique in that it provides remote supervision of operation and centralized manual control to meet emergency conditions more effectively.

The main and spare transmitters are of conventional tube-type carrier design having a 10-watt output. These are capacitance-coupled to the 4-kv bus through a 15-kvar line-type capacitor.

The switching receiver is transistorized, is plug-in mounted on the capacitor bank, and is connected to a ferrite antenna mounted under the feeder crossarm. All maintenance is performed under shop conditions.

Signal propagation over the feeders permits bank location at almost any site desired, whether the feeder is all overhead, all underground, or a combination of both types.

More than 100 banks, rated 300 kvar each, are now being controlled by this remote-carrier method, and as many more are being installed for 1958. Operating experience to the present indicates that signal propagation is satisfactory for reliable operation, and any reasonable bus voltage schedule may be maintained.

Digest of paper 58-868, "Benefits of Line Capacitors Extended by Remote Automatic Control," recommended by the AIEE System Engineering and Transmission and Distribution Committees for presentation at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Published in AIEE *Power Apparatus and Systems*, Dec. 1958, pp. 945-50.

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Battery Impedance

Farads, Milliohms, Microhenries

E. WILLIHNGANZ

PETER ROHNER

Very little has been published on the resistance, capacitance, and inductance of storage batteries. A study made to obtain actual measured values of these important parameters is described.

THE ELECTRICAL RESISTANCE of storage batteries is an important property to two groups of people. Designers of telephone equipment need to know the resistance to alternating current in order to evaluate the cross talk between simultaneous telephone conversations which must pass through the central station battery. They must also be able to evaluate the amount of filtering required to remove hum, noise, and switching pulses from the output of the charging and switching equipment. In addition, designers of central power stations need to know the resistance of the battery which must supply short pulses of power to operate electric switches.

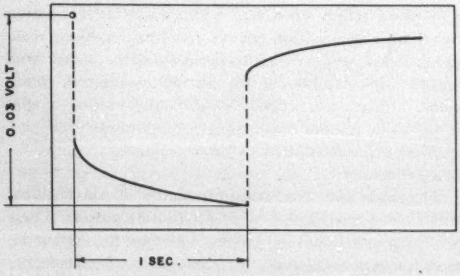

Fig. 1. Battery voltage during square wave pulse.

Surprisingly little has been published about the electrical resistance of batteries. G. W. Vinal[1] reviews what has been published. Most of the published material deals with methods of test and the cause of discrepancies between the various methods. There is, however, practically no data of interest to the engineer dealing with commercial types of batteries.

This work, therefore, has been undertaken to supply actual measured resistance values on batteries which are of engineering interest. A series of telephone-type lead–calcium batteries was selected for this test inasmuch as they appear to be the type of greatest importance today.

PROPERTIES

THE BATTERY PROPERTIES to be discussed are illustrated in Fig. 1. This is an oscillogram of the cell voltage during a 1-second discharge at about the 1-hour rate. When the discharge begins, there is a sudden decrease of voltage because of electrical resistance, and then a gradual decrease in voltage caused by chemical changes occurring at the surface of the active materials. When the discharge is interrupted, the voltage recovers in the same sequence.

The electrical resistance can be calculated from either the sudden voltage change at the beginning of the discharge, or the sudden change at the end of discharge.

The rest of the curve represents the result of chemical changes. The chemical changes within the battery produce a counter electromotive force (emf) called polarization. This polarization cannot be precisely duplicated by a combination of the ordinary circuit elements, but it can be approximated by a capacitance shunted by a leakage resistance. The capacitance is responsible for the initial slope of polarization curve, while the leakage resistance is responsible for the curvature of this line.

The battery also possesses a measurable inductance. The initial part of the polarization curve shows a slight irregularity. Where the current is large, or the pulse length short, this irregularity can be clearly identified as the result of battery inductance. When large batteries are being studied, the effect of inductance assumes a major importance.

The equivalent circuit of a battery, therefore, contains a resistance, an inductance, and a capacitance (Fig. 2). This capacitance is shunted by a nonlinear resistor. The battery resistance has been divided between the metal resistance R_M and the acid resistance R_A. The resistance of the active material has been ignored, inasmuch as it is believed to be negligible.

Because of the wide range of battery sizes tested, results were reduced to an ampere-hour basis. The measured resistance was multiplied by the ampere-hour rating of the battery, and the measured capacitance was divided by the ampere-hour rating of the battery. The inductance measurements, however, are tabulated directly without calculation, because they varied only slightly with battery size.

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MEASUREMENTS

THE OSCILLOGRAMS were used principally to define the terms used. All batteries were first tested using oscillograms, but this report contains principally Wheatstone bridge measurements, because they are not only more precise, but also considerably easier to obtain.

The bridge is shown in Fig. 3. The test cell was bolted directly to an ammeter shunt which served as a standard resistor R_2. The shunt was then bolted to a straight copper rod of negligible resistance which served as a variable inductor L_2 by using a traveling contact. The ratio arm R_4 was a 100,000-ohm fixed resistor. The measuring arm consisted of an adjustable resistor R_3, 0 to 1 megohm, and an adjustable capacitor C_3, 0 to 1 microfarad. The null indicator is a cathode-ray oscillograph with vertical plates across the bridge and horizontal plates across the variable-frequency oscillator.

The bridge was used only up to 5,000 cycles because of battery properties. The bridge was checked by comparing ammeter shunts and was found to be within 1% over a frequency range up to at least 50,000 cycles.

For measurements, the bridge was first balanced for resistance and inductance at 5,000 cycles, with the capacitance omitted. The inductance setting was then left unchanged while the bridge was balanced for resistance and capacitance at 1,000 cycles.

Inductance. The inductance of batteries is summarized in Fig. 4 and is about 0.1 microhenry. The 10–1,000 ampere-hour part of the chart describes batteries having single posts. The 300–1,600 ampere-hour section describes batteries with double posts. For these larger batteries, a heavy copper bus bar was firmly bolted to both positive posts, and another similar bar bolted to the negative posts. Bridge connections were made to the mid-point of these copper bars. The chart shows the result of measurements at 5,000 cycles.

The voltage developed across the inductance was measured directly with a calibrated oscillograph and compared with the voltage developed across the ammeter shunt so that the inductive reactance could be calculated. This was then translated into inductance.

Resistance. The resistance measured at 1,000 cycles and multiplied by the ampere-hour capacity rating of the battery is shown in Fig. 5.

The smaller batteries show 0.14 ohm for the range of 10 to 100 ampere-hours. In these batteries the metal parts are relatively large, their size being determined by mechanical needs rather than by electrical resistance. Calculation shows that most of this battery resistance is

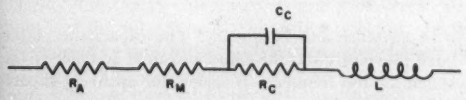

Fig. 2. Equivalent circuit of a battery.

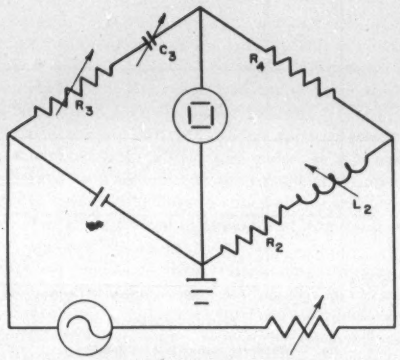

Fig. 3. Wheatstone bridge.

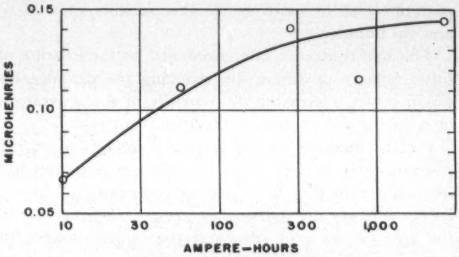

Fig. 4. Inductance vs battery size.

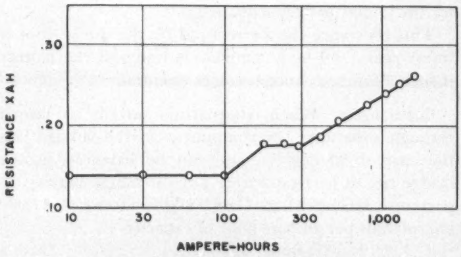

Fig. 5. Resistance vs battery size.

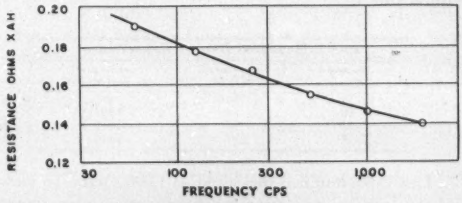

Fig. 6 Apparent resistance vs frequency.

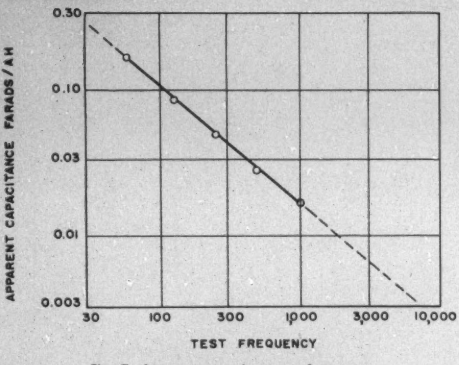

Fig. 7. Apparent capacitance vs frequency.

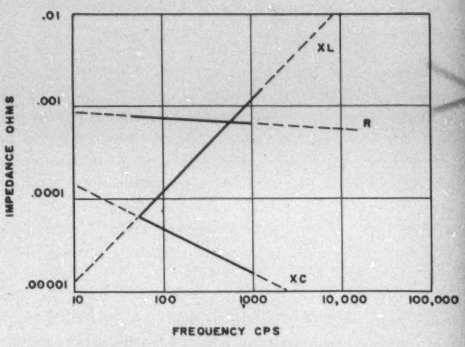

Fig. 8. Impedance components of 180-ampere-hour battery.

caused by acid between the plates. Therefore, we have considered R_A as 0.14 ohm. This represents the acid path modified by the presence of separators, glass mats, and gas bubbles.

The acid resistance can be reduced, at the expense of other battery properties by reducing the distance between plates, increasing the porosity of the separators, or reducing the number of layers of insulation.

For the batteries of 180 ampere-hours or larger, the resistance per ampere hour is no longer constant, but increases gradually. It is believed that part of this reflects the larger size without a corresponding increase in the area of the grid ribs, and the larger number of plates, which require a longer strap to connect the plates to the post. Finally, the posts contribute significantly to the battery resistance in the larger battery sizes. These effects may amount to as much as 0.1 ohm for the largest battery sizes.

This resistance can be reduced by the use of copper insert posts, and by a complete redesign of the battery if such a low resistance becomes essential.

Capacitance. When alternating current is passed through a battery, one component of the voltage lags the current 90 degrees, and can be balanced in the bridge circuit by a capacitor. The calculated battery capacitance is surprisingly large and amounts to 17,000 microfarads per ampere-hour of capacity.

A 1,000-ampere-hour cell would, therefore, have a capacitance of 17 farads. This is several orders of magnitude larger than any other capacitor known, and offers a new circuit element for filtering or energy storage applications.

Table I. Measured Battery Capacitance

Ampere-Hours	Capacitance, farads	Farads per Ampere-Hour
10	0.16	0.016
50	1.05	0.021
300	5.1	0.017
840	13.5	0.016

This capacitance is measured at 1,000 cycles. In view of the leakage resistance R_C the apparent capacitance becomes considerably greater at low frequencies. This will be discussed later.

Leakage Resistance. The battery capacitance describes only the initial slope of the voltage curve. The subsequent slope can be approximated by using the time constant of the circuit. The time required for 63% of the polarization to disappear amounts to about 3,000 microseconds, and this time constant corresponds to that of a 0.016-farad capacitor discharging through a resistance of approximately 0.20 ohm. Since this is on an ampere-hour basis, the leakage resistance is, therefore, 0.20 ohm-ampere-hour.

Where the discharge is at a high rate, and lasts for more than a second, this simplified picture no longer appears to be valid. The shape of the curve becomes more complex, and wide variations of the leakage resistance may be observed. This aspect of battery properties is not yet clear.

Where, instead of using pulse tests, the a-c bridge is used, the capacitance and leakage resistance form a frequency-sensitive network which can dissipate energy. The apparent capacitance and resistance, therefore, will vary with the frequency and because the equivalent circuit is not quantitatively correct, the variation with frequency must be measured.

Resistance and Frequency. The internal resistance of the battery has, up to this point, been the resistance measured at 1,000 cycles, and it has been found that this is identical with the resistance read from the pulse oscillogram of Fig. 2. If the test frequency is varied, part of the a-c energy is dissipated by the chemical reaction and shows up as an apparent increase in resistance as seen by the bridge circuit. This effect of frequency is shown in Fig. 6.

Capacitance and Frequency. The capacitance tabulated previously was the value measured at 1,000 cycles. When the test frequency is varied, the apparent capacitance varies, and the results can be plotted on a straight line up to 1,000 cycles, as shown in Fig. 7. At higher

frequencies, a battery introduces too much inductance, but by using a specially designed test cell Lange has indicated that this line is straight to at least 20,000 cycles, provided data are plotted on logarithmic scales.

Relative Importance of Impedance Components. Up to this point, the discussion has been primarily on an ampere-hour basis in order to minimize the effect of battery size. The absolute values of the components of the battery impedance are shown in Fig. 8 for a 180-ampere-hour cell. The experimental points fall on the solid line. Dotted extensions on these lines show where we would expect the lines to fall if the areas were accessible to experimental work.

It is clearly evident that the inductance of the battery controls its counter emf at high frequencies, and in view of the data in Fig. 4, the position of this line will not shift seriously with battery size.

At low frequencies, both resistance and capacitive impedance control the counter emf. These vary inversely with battery size, and for an 18-ampere-hour battery the values would be 10 times the quantities shown.

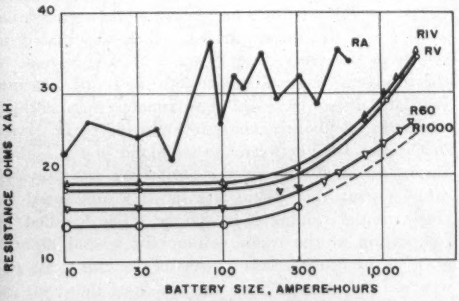

Fig. 9. Practical resistance measurements.

Practical Resistance Measurements. Various numbers associated with the electrical resistance are shown in Fig. 9.

The bottom line shows the resistance measured by the a-c bridge at 1,000 cycles.

The resistance measured at 60 cycles is shown next. This measurement avoids the need for a 1,000-cycle generator with an output of 100 amperes for measuring the resistance of the larger batteries, and also makes inductance troubles less important.

The next curve R_V is the "virtual" resistance. If a battery is discharged for 5 seconds at a preselected current and the voltage is read immediately before and 5 seconds after the current interruption, the change in voltage divided by the current gives an apparent resistance which we have called the virtual resistance.

The next curve shows the resistance R_{IV} measured by the initial-voltage line. If the voltage after 5 seconds of discharge is measured at various current levels, and the voltage is plotted against the current, this is described as the initial-voltage line. The points fall on a straight line over most of the range, and the slope of this line can be regarded as an electrical resistance.

Finally, the top curve shows the apparent resistance R_A calculated from a discharge pulse. If a battery is discharged for 5 seconds and the voltage at the end of 5 seconds is subtracted from the open-circuit voltage, and the difference is divided by the current, the result is another apparent resistance.

Of these various methods of measuring resistance, the 1,000-cycle method comes closest to giving the actual resistance, and the other methods include various amounts of polarization. Obviously, whenever resistance is mentioned, the method of measurement should be specified and we suggest that the word "resistance" be limited to the 1,000-cycle results and the term "virtual resistance" be reserved for one of the pulse tests, preferably the current-interruption method.

SUMMARY

From this discussion, it can be seen that the apparent capacitance of a battery will be in the range of 1 farad to several hundred farads, depending on the size and test frequency. The resistance will be 0.1 to 10 milliohms, depending on the battery size, and the inductance will be less than 0.1 microhenry.

These quantities are in the expected range, except for the capacitance, which is so large that it offers an interesting challenge to the electrical engineer. There must be places where a capacitor of these characteristics is needed.

REFERENCE

1. Storage Batteries (book), G. W. Vinal. John Wiley & Sons, Inc., New York, N. Y., 1955.

Transportable Station

A transportable single-sideband communication station for tactical field operation has been designed and constructed by the Collins Radio Company in conjunction with the U. S. Army Signal Research and Development Laboratory. Delivery has been made on 2 of the 15 stations on order, each of which measures about 5 by 6 by 6 feet and weighs less than 2,000 pounds. The Collins-designed *18Z-3* single-sideband communication system employed by the stations provides radio extension for 2- or 4-wire land-line voice circuits. Commercial or motor–generator power may be used for the stations, which require only one nontechnical operator. The units, which may be transported by helicopter or ¾-ton truck, can be completely set up and ready for operation within a half hour.

Global Public Telephone Service
1958

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MEMBER AIEE

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A review of some aspects of global public telephone service in the light of the important developments that have taken place within the period of 1954 through the Fall of 1958—notably the growing number of underseas telephone cable circuits, and the trend toward the use of radio for domestic networks and for relatively short links to nearby islands.

OVERSEAS public telephone service between the United States and other areas in the world has continued to grow since 1953, not only in the number of areas reached, which has increased more than 20%, but also in the number of overseas public telephone messages which are handled. The volume of messages has increased approximately 87% over the number handled in 1953, as can be seen from Fig. 1, which shows the total overseas public messages between the United States mainland and other areas by years. It will be noted that the placing in service of the transatlantic telephone cable system between the United States and Great Britain in September 1956 contributed very substantially to the growth of traffic experienced. As a matter of interest, one year after the transatlantic cable system was in service the volume of messages with Great Britain had increased approximately 90%, with substantial increase also being experienced with those countries on the European continent which are served by direct circuits in this cable system. Another point of interest is that, after the cable system had been placed in operation, it was noted that the average length of conversations between the United States and Great Britain had increased approximately 20% and a similar but somewhat smaller increase was experienced between the United States and countries in Europe served by the cable.

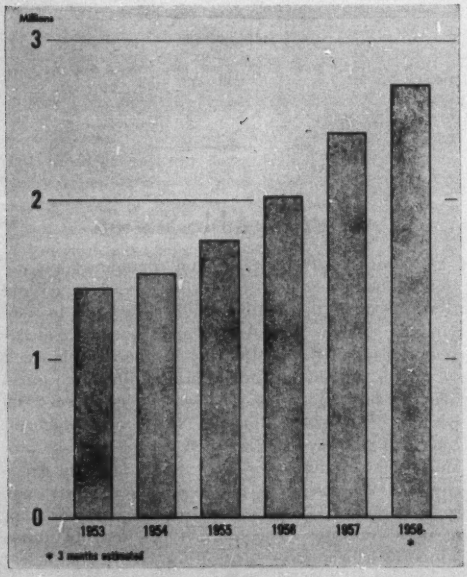

Fig. 1 Overseas messages.

The first telephone cable system across the Atlantic Ocean was followed by a similar system between Seattle, Wash., and Ketchikan, Alaska, which was placed in service in December, 1956. Again, a marked increase in the volume of traffic occurred, with the result that, one year later, it had increased approximately 30%. A third underseas telephone cable system was placed in service in October 1957 between the mainland of the United States and Hawaii. As in the case of the two previous cable systems, this system also shows a substantial increase in the volume of telephone traffic handled. A comparison of the traffic volume for several months prior to the introduction of service over this cable system and the same period one year later shows an increase in the order of 50%.

Fig. 2 shows the various overseas points which are connected with the Bell System to furnish public telephone service. The dots indicate points served by direct circuits or links and the circles are points served by switched circuits; for example, service with the Canary Islands is furnished via Madrid. It can be seen that there are relatively few areas in the world with which service is not available.

UNDERSEAS PUBLIC TELEPHONE CABLE SYSTEMS

THE UNDERSEAS telephone cable systems between the United States mainland and Great Britain, Alaska, and Hawaii, respectively, are indicated by the solid lines in Fig. 2. The dashed lines on this figure show systems planned to the European continent and to Puerto Rico. The basic design of these systems is the same in that a pair of cables is used (one in each direction of transmission); each cable providing 36 voice channels of nor-

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Fig. 2. Overseas points of communication and cable routes.

mal bandwidth using built-in flexible repeaters. The cables are powered from the cable terminal stations.

The transatlantic cable system terminals are at White Plains, N. Y.; Montreal, Que., Canada; and London, England, with only the terminals of the deep sea cable portion located at Clarenville, Newfoundland, and Oban, Scotland. This system is a joint project of the General Post Office in England, the Canadian Overseas Telecommunication Corporation, and the American Telephone & Telegraph Company (AT&T). Of the 36 voice channels in the system, 29½ are allocated for United States traffic and 6½ for Canadian traffic. From the deep sea cable terminal at Clarenville, the United States channels are extended to White Plains by means of a submarine cable system between Clarenville, and Sydney Mines, Nova Scotia; by a *TD-2* microwave radio relay system from the latter point to Portland, Maine; and by cable carrier groups to White Plains. The Canadian channels branch off at Spruce Lake, a station on the *TD-2* route in Canada, and are extended to Montreal on facilities comparable to those used in the United States. In the United States group, a number of the circuits are extended from London to points on the European continent for service with those countries. As the channels in this system are loaded to capacity, discussions are under way between the partners in this project looking toward increasing the number of voice channels to handle the continuing growth in traffic.

The underseas portion of the Alaska system extends from Port Angeles, Wash., to Ketchikan, Alaska, with an extension at the United States end to Seattle where it connects with the domestic long-distance network. At Ketchikan, the 36 voice channels connect to facilities of the Alaska Communications System (ACS) to furnish telephone service to various points throughout Alaska. Between Ketchikan and Skagway in Alaska, service is furnished over ACS facilities that consist of a single underseas cable using land-based repeaters.

The underseas telephone cable system with Hawaii is a joint project of AT&T and the Hawaiian Telephone Company. The deep sea cable terminals are located at Point Arena, Calif., and Hanauma Bay on the island of Oahu with the system terminals at Oakland and Sacramento, Calif., and Honolulu. The deep sea portion of this system is the longest of the three in operation, extending approximately 2,540 miles with 57 cable repeaters in each direction. With the commencement of service over this cable system, overseas dialing was inaugurated simultaneously. On the United States mainland, any long distance operator with access to the dialing network can dial a call to any number in Hawaii connected to the dialing network in that area and similarly in the opposite direction from Hawaii to the United States mainland. As the channels in this cable are equipped for dialing and a number of the radio circuits between Oakland and Honolulu are also maintained in operation, it was necessary to equip the radio circuits for dial operation. This is discussed later in the article.

These cable systems provide high quality telephone circuits which meet the same transmission requirements as domestic circuits of comparable lengths in the United States. These circuits are free from fading and have a low noise level which is not subject to fluctuations due to radio propagation variations. The transmission-frequency characteristics are stable, as contrasted with the variations encountered in high-frequency radio circuits resulting from selective fading. They are free from the usual propagation outages on radio that result from magnetic storms and sudden ionospheric disturbances particularly on the North Atlantic and Alaska routes.

With the success of the three undersea telephone cable systems already in operation, it became evident that additional cable systems would be required wherever they were needed to handle large volumes of traffic and could be justified from an economic viewpoint. Plans have been made and construction has commenced on a second underseas telephone cable system across the Atlantic Ocean between the United States and the continent of Europe. Service is expected in late 1959. Partners in this project are the government administrations of France and Germany, together with AT&T. The deep sea cable terminals for this system will be at Clarenville, Newfoundland, and Penmarch, France. Another system is planned between the United States mainland and Puerto Rico for service in early 1960. This will be a joint project of AT&T and the Radio Corporation of Puerto Rico, a subsidiary of the International Telephone & Telegraph Corporation. The cable terminals of this system will be at West Palm Beach, Fla., and San Juan, Puerto Rico. The basic design of these two systems will be the same as the three already in service.

As satisfactory results were obtained with traffic operator dialing on the circuits in the Hawaiian cable system, plans were made to introduce dialing on the Alaska circuits early in 1959. Also, it is planned to introduce dialing on the Puerto Rico circuits when that underseas cable system is placed in service.

OVER-THE-HORIZON RADIO

THE DEVELOPMENT of over-the-horizon or tropospheric scatter radio techniques for multichannel telephone systems has been a significant development in the last few years. This technique permits the establishment of radio links of 200 miles or longer depending on the number of voice channels desired, using radio frequencies in the uhf range. Such systems, when carefully engineered are capable of providing highly reliable service for a group of telephone circuits up to about 200 in number. Relatively high-power transmitters and large antennas are required for the longer distances and larger numbers of circuits.

The great advantages of this technique lie in the high reliability of the circuits as compared to circuits using high-frequency radio techniques, especially in regions of the world subject to great ionospheric propagation instability. The quality of the circuits provided compares very favorably with those provided by line-of-sight microwave techniques or by cable facilities. Operating as they do in the uhf part of the frequency spectrum,

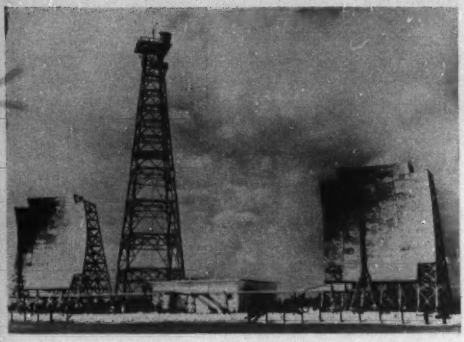

Fig. 3. Florida City Station with 60-foot antennas and microwave tower.

such systems avoid additional crowding of the 2-7 mc frequency range required for the 200-mile distance range when using ionospheric reflection radio techniques. Frequencies in this latter range would not be available in many parts of the world to provide telephone circuits in the quantities that are possible by over-the-horizon systems.

From an economic standpoint, the over-the-horizon system is usually somewhat less costly than a deep sea repeatered submarine cable, especially when the number of telephone circuits approach the maximum which the system is capable of handling. For small numbers of circuits, radio using the ionospheric reflection techniques is far less expensive but does not approach over-the-horizon techniques in quality and reliability. Where line-of-sight radio systems using intermediate repeaters are readily installed and maintained, it appears that such systems will usually be less costly.

An important radio link of this type has been provided between Florida City, Fla., and Guanabo, Cuba, by the AT&T on the Florida end and the Radio Corporation of Cuba, a subsidiary of the International Telephone & Telegraph Corporation, on the Cuban end. A description of the general features of this system follows:

This system employs 10-kw transmitters and 60-foot parabolic reflector antennas. Two channels are provided for full protection of service. Each channel employs space diversity reception, and diversity combining of the two channels is also provided. At the United States end, a two-link *TD-2* microwave system connects to Miami, and at the Cuban end, a similar single link connects to Havana. Fig. 3 shows a general view of the Florida City Station indicating the 60-foot parabolas and the *TD-2* tower. Fig. 4 shows the route layout of the system. This figure also shows the proposed system to Nassau, Bahamas, which is planned for service by the end of 1959. Whereas the Cuban system operates in the 700- to 900-mc band, it is proposed to operate the Nassau system in the 2,000- to 2,200-mc band. In the latter system, 30-foot parabolic antennas are being employed.

At present, the Cuban system is providing 36 telephone circuits of the same general grade of quality and reliability as are provided by the cable circuits on the route to Cuba. It is capable of an ultimate capacity in excess of 100 circuits when growth requires this number. Video service also is being provided over this system on an occasional basis as required, making use of the second radio channel which is provided for protection. Because of selective fading, video service is not entirely comparable to that provided over line-of-sight microwave systems, but monochrome signals acceptable for broadcasting are being received over the system with a high degree of reliability.

Other systems employing over-the-horizon techniques have been provided elsewhere in the world. The most extensive of these used for public telephone service is the Alaska Communication System project called White Alice. This is a joint military and public telephone service system. Other systems used for public telephone service have been installed in Canada, the Caribbean area, and in the European area.

HIGH-FREQUENCY RADIO

HIGH-FREQUENCY RADIO continues to provide the facilities for most of the transoceanic links in the world telephone network. Although the use of cables on major traffic routes and over-the-horizon links in a few cases where they are feasible will continue to increase, it appears that high-frequency ionospheric reflection techniques will continue to play a major role in the international public telephone service for many years to come. They are necessary to serve many places where cable is not feasible and over-the-horizon radio techniques are not applicable. They are required to parallel cable routes to provide protection and dispersion of facilities. These radio facilities also provide direct connection between countries where the cable routes traverse intermediate countries. It is urgently desirable that these facilities be improved in quality and reliability. A number of trends are evident in this direction.

The use of single sideband techniques continues to expand and provides an improvement in service both in signal-to-noise ratio for equivalent power output and a

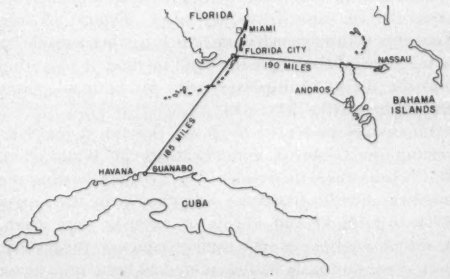

Fig. 4. Over-the-horizon system routes at Florida City, Fla.

quality improvement. The most important advantage of this technique is, however, the conservation in spectrum occupancy which it provides. The overseas public radiotelephone circuits terminating in the United States are approximately 95% on a single-sideband basis now, and this percentage is increasing steadily.

There is also a trend toward the use of higher power on transoceanic circuits. In this connection, AT&T has recently placed in service 10 newly designed 30-kw power amplifiers. The provision of additional amplifiers is planned for services where a significant improvement in service continuity can be obtained.

This is a single-stage amplifier designed by the Westinghouse Electric Corporation to Bell System specifications. It operates in the frequency range 4 to 26.5 mc, utilizing two Machlett type *6423* air-cooled vacuum tubes connected in parallel and operated in a grounded grid circuit. A peak envelope power of 30 kw is provided into a balanced load of from 200 to 900 ohms of resistance when driven by an exciter capable of an output of 2.5-kw peak envelope power. The amplifier output π network is somewhat unique in that there are no roller or sliding contacts, the tuning being accomplished by means of fixed coils and variable vacuum capacitors, the required combination being switched in by means of vacuum relays.

A servo system is incorporated in the amplifier and is arranged for interconnection with the servo system of the Western Electric Company *LD-T2* transmitter used as a driver in such a way that any one of 10 preset frequencies may be selected by pushbutton control either at the equipment or, with suitable circuits, from a remote point. Fig. 5 gives a view of part of the transmitter room at the Lawrenceville, N. J., station showing these amplifiers with the *LD-T2* driver units.

These are being used on the European paths which approach the Auroral Zone and are most in need of improvement. Most of the European countries where these circuits terminate have also installed equipment of comparable power output.

Fig. 5. Amplifiers at the Lawrenceville, N. J., transmitting station.

HIGH-FREQUENCY RADIO SPECTRUM

With the increasing number of fixed radio services operating in the high-frequency range, it has been necessary to take advantage of all available techniques to obtain improved utilization of the spectrum and conserve the available frequency space. Typical of such measures is the extensive use which has been made for many years of the single-sideband method of operation and the use of multiplex systems for both telephony and telegraphy.

In a paper presented by D. D. Donald at the Symposium on Global Communications in Washington, D. C., June 1954, the results of an analysis showing the number of radio frequency assignments in the ranges 7,300 to 8,195 kc and 14,350 to 14,990 kc were given. A recent analysis of the same frequency ranges has been made and it shows that there had been an increase of approximately 35% in the number of stations which have registered for operation in these bands. On the average, there are more than 13 stations registered for every kilocycle in the 7,300- to 8,195-kc range and more than 2 stations for every kilocycle in the 14,350- to 14,990-kc range. Considering that each telephone circuit requires a minimum of 3 kc of spectrum space, it can be seen that the likelihood of finding additional frequencies which are clear of interference to provide service expansion is extremely difficult in most parts of the world.

As the overseas public telephone service is continuing to grow, the provision of additional telephone circuits by high-frequency radio using the most efficient multichannel single-sideband techniques would require the continuous use of 108 kc of spectrum space in each direction of transmission to furnish 36 circuits, or the basic capacity of one underseas cable system. This would, depending on the route, require assignments totaling 216 kc in each of 4 or 5 different frequency ranges, each being used part time, depending on propagation conditions. It seems extremely doubtful if spectrum space could be made available, particularly in the congested North Atlantic area, to handle circuit increases of this magnitude.

LINE-OF-SIGHT MICROWAVE RADIO RELAY SYSTEMS

Another significant development in recent years has been the rapid expansion in the use of line-of-sight microwave radio relay systems in the public telephone networks. This has been particularly true in the United States and Canada and there is considerable use of these systems in Europe and other parts of the world.

The major microwave radio relay routes of the Bell System and connecting carriers used for public telephone service extend from coast-to-coast and from Canada to southern United States. Most of these routes employ the Western Electric *TD-2* radio system. Many sections have been developed to the full capacity of six channels in each direction for telephone and television purposes. The individual radio channels used for telephony are generally developed for about 600 telephone circuits. In deriving the telephone circuits, a frequency-division single-sideband carrier technique is used employing the same carrier systems as are used on coaxial

cables. The combined carrier signal is transmitted over the radio system by frequency modulation.

In the United States, a large part of the new long-distance telephone facilities provided in recent years have employed microwave facilities. Experience indicates that this is a highly reliable and economical method of handling telephone service as well as the network television service.

OVERSEAS DIALING

THE GROWTH IN TRAFFIC in the overseas service has made it desirable to consider improved methods of handling calls. Experience in the United States and other countries indicates that calls can be more speedily and accurately established by properly engineered dialing systems. Rapid strides have been made in the United States in applying dial signaling systems to the long-distance network. It was only natural that, as the business to Hawaii grew, consideration should be given to extending this method to that area.

The transmission of dial signaling information and supervisory signals over the underseas telephone cables presents no new problems. The same general methods as are used throughout the United States long-distance network can be employed with appropriate terminal facilities to integrate them with the local dial facilities.

The transmission of signaling information with adequate reliability is a problem on high-frequency radio circuits. It is well known that on high-frequency radio circuits using ionospheric reflections, any single frequency signal is subject to more or less continuous variations in received level due to multipath fading. In telegraph systems these are largely overcome by diversity and frequency shift methods.

The requirements of a dial signaling system for high-frequency radiotelephone circuits are that the signaling tones must be contained within the normal bandwidth of the telephone circuit to conserve the use of the frequency spectrum, the tones must not be transmitted continuously so that the radio transmitter will not be loaded excessively, and the required signals must be received with adequate reliability during all radio propagation conditions during which the telephone circuit is suitable for conversation by the public.

A signaling system meeting these requirements has been developed and is being used successfully on the radiotelephone circuits to Hawaii. This sends tones at 800 and 1,900 cycles which are within the telephone band during intervals when signals are required. Tones are sent in duplicate, spaced 1,100 cycles apart to provide frequency diversity and dial pulses are sent by frequency shift where the frequency of both tones are shifted 200 cycles upward in frequency.

This method is applicable to any high-frequency radiotelephone route where dial signaling is desired. There are a number of problems in introducing dial signaling to foreign countries. When these are resolved, it is expected that dial signaling will be expanded. Early applications are expected to be on routes having combined cable and radio facilities. On such routes, it is felt that the radio facilities normally used should be equipped for dialing as well as the cable circuits.

SUMMARY AND CONCLUSION

THERE HAS BEEN a remarkable growth in transoceanic telephone communications in recent years. This has been stimulated particularly by the provision of underseas telephone cable circuits which provide service in quantity and quality far surpassing what has heretofore been available.

In contrast to the trend toward using cable in long transoceanic circuits, for which radio has in the past been the means of telephone communications, there is an opposite trend toward using radio for domestic networks and the rather short links to nearby islands. The expanding use of line-of-sight and over-the-horizon radio systems is clearly evident. These systems provide circuits in quality and quantity comparable to what can be provided by wire methods.

High-frequency ionospheric-reflection radio continues to be a major method of transoceanic communications. The extension of single-sideband techniques to those cases where this method was not already used and the provision of higher power are improving these communications.

As the major telephone networks are brought closer together by these new facilities, a need exists for improved operating methods including dial signaling. Means have been developed to apply these methods to high-frequency radiotelephone circuits in spite of the transmission difficulties due to multipath fading.

In conclusion, the continuation of present trends seems a certainty. Expansion in the domestic telephone network by means of microwave radio will continue. Additional over-the-horizon radio systems and underseas telephone cable systems for public telephone service will be provided as the circumstances warrant.

The provision of high grade telephone circuits by underseas cables requires large investments. To help offset the costs of such facilities, means are being developed to use existing cables more efficiently. For example, a system called TASI, a convenient name for Time Assignment Speech Interpolation, is under development in the Bell Telephone Laboratories and seems likely to double the capacity of existing cables. This it will do by taking advantage of the times when people are listening or pausing. The voice channels they leave temporarily unused will be automatically assigned to other talkers; and when a listener starts to talk, he will instantly have the use of a channel which another person has left idle. Wider bandwidth repeatered underseas cables also will be developed to reduce the cost per circuit where large quantities of circuits are required. The recently announced cable system between the United Kingdom and Canada promises to be a step in this direction, providing 60 circuits with both directions of transmission in the same cable sheath. These developments and others will make for an ever expanding and more economical global public telephone communication network.

INSTITUTE ACTIVITIES

Seattle Is Host to AIEE Summer and Pacific General Meeting

SEATTLE, WASH., was host to the AIEE Summer and Pacific General Meeting, held June 21-26, 1959, at the Olympic Hotel in conjunction with the AIEE Air Transportation Conference, whose theme was "Electricity in Space." The combined attendance was more than 2,000 members and guests, who celebrated the Diamond Jubilee of the Institute's founding.

There were 79 technical sessions during the 5 days of the meeting at which more than 300 papers were presented. The Air Transportation Conference had 13 sessions at which more than 50 papers were given.

The inspection trips program was varied in scope so that members' general and technical interests would be satisfied. Trips were made to several hydroelectric plants in the vicinity on an aerial cruise, to the Puget Sound Naval Shipyard, to lumber and paper mills, to two plants of the Boeing Airplane Co., and to the Pacific Telephone & Telegraph Co.

The social activities of the meeting started with a welcoming party on Sunday afternoon; on Tuesday evening, there was an informal dance; on Wednesday, a theater party, and on Thursday afternoon and evening, a Kiana Potlach Salmon Barbecue on nearby Bainbridge Island. The ladies' activities included a color lecture and tea, a sightseeing tour of Seattle with tea at the Art Museum, a fashion show, brunch, and a flower arrangement demonstration.

Two member luncheons were held on Tuesday and Wednesday. President-elect J. H. Foote spoke at the first, which was a special observance of the Institute's 75th birthday. The speaker at the Wednesday luncheon was L. A. Wood of the Pilotless Aircraft Division of Boeing Airplane Company.

An unusual feature was provided by N. F. Schuh and R. J. Tallent, of Westinghouse and Boeing, respectively. This was a working model of a solar-powered thermoelectric generator, exhibited on the hotel's roof for the press and television reporters.

The two engineers, who also presented a technical paper on the generator, stated that the 20- by 50-inch semispherical collector of the sun's energy concentrated the sunlight onto the thermoelectric material having a power output of 2.5 watts. This is sufficient to run a small motor in bright sunshine.

The purpose of the study resulting in this generator is to develop a secondary source of power for operating electric equipment in satellites and missiles.

General Session

H. R. Loew, general chairman of the meeting, presided at the combined general session and annual meeting, held June 22. The invocation was given by Rev. Edward Hummon, pastor of the University Lutheran Church. Brief welcoming addresses were presented by Mayor G. S. Clinton of the City of Seattle; G. D. Jorgensen, chairman, Seattle Section, and J. M. Nelson, vice-president, District No. 9.

AIEE President L. F. Hickernell then presented the annual treasurer's report. For the fiscal year ending April 30, 1959, total income was $1,677,922, and total expenses, $1,743,856, resulting in a deficit of expenses over income of $65,934. This was about $12,000 less than the budgeted deficit of over $78,000. A detailed report of the financial position of the Institute, as of April 30, 1959, is included in the printed "Report of the Board of Directors, 1958-59," which is summarized in the August 1959 issue of *Electrical Engineering*, pp. 856-59.

It was concluded that the trends of increasing expenses, without proportionate increases in income, indicate the need for remedial action. Suggested approaches include (1) extending policies toward making activities more nearly self-supporting; (2) considering the emphasis toward Special Technical Conferences as contrasted to General Meetings in terms of number, frequency, and value contributed; (3) reviewing the policies on travel expenses; and (4) promoting vigorous advertising sales programs.

President Hickernell also reported on the balloting on the new constitution, which was overwhelmingly approved. He then introduced the officers-elect of the Institute for 1959-60. They are: *President*—J. H. Foote; *Vice-Presidents*—District No. 2, D. L. Greene; District No. 4, J. W. Davis; District No. 6, M. H. Kight; District No. 8, G. T. Harness; District No. 10, Rene Dupuis; District No. 12, F. S. Bacon; *Directors*—Hendley Blackmon, E. I. Green, S. M. Osthagen; *Treasurer*—C. H. Linder.

F. D. Robbins, University of Washington, presented the Student Prize Paper Awards. Winners were: District No. 1, D. M. Davies and R. L. Allen, Clarkson College of Technology; District No. 2, I. E. Sutherland, Carnegie Institute of Technology; District No. 3, Robert Sommer, New York University; District No. 4, W. E. Montgomery, Duke University; District No. 5, R. G. Buus, University of North Dakota; District No. 6, Robert Allington, University of Nebraska; District No. 7, R. M. Goldwyn, Rice Institute; District No. 8, F. A. Spelman, Stanford University; District No. 9, G. F. Miner, University of Utah; District No. 10, no contest; District No. 11, R. W. Hall, University of Toledo; District No. 12, J. J. Panico, Northeastern University; and District No. 13, W. W. Clements, University of Alabama.

The last item on the agenda was the presentation of the Lamme Medal to Sterling Beckwith and P. L. Alger. Mark Princi outlined the history of the medal, and L. T. Rosenberg and B. M. Cain presented biographies of the recipients. The

L. F. HICKERNELL *(left)*, 1958-59 president of the AIEE, pins a badge on J. H. Foote *(right)*, Jackson, Mich., who took office August 1 as 1959-60 Institute president. Mr. Foote is chief engineer of Commonwealth Associates, and vice-president and director of engineering for Commonwealth Services, Inc., at Jackson. He has long been active in Michigan and national AIEE affairs.

Courtesy F. J. McGrail

text of the history, biographies, and responses may be found in the August 1959 issue of *Electrical Engineering*, pp. 819-26.

75th Anniversary Luncheon

The luncheon was opened by AIEE Vice-President J. M. Nelson of District No. 9, who extended a cordial welcome and drew attention to the 75th Anniversary of the Institute. R. Deeuwkes (AM '07, F '20), M. T. Crawford (AM '07, F '22), and Dean E. A. Loew (AM '03, F '36) were introduced as senior citizens of Seattle; all three had served as chairmen of the Seattle Section (founded in 1905) and all three are Members for Life.

In his address, Dean Loew described the Institute as a service organization which holds forums and makes possible the reporting and discussion of problems, a record of which has been preserved in an outstanding library. The early work of C. P. Steinmetz was referred to by the speaker. These books, such as "The Use of Complex Numbers for Steady State Studies of Circuits," are already considered classics.

Dean Loew considered the establishment of the Student Branches, which now number 163 in the United States, as another outstanding service. He expressed pride in having been a member for so many years.

The early history of Seattle and the story of the first power station, which consisted of two 600-lamp, 16-candlepower generators, approximately 40 kw, was told by A. L. Pollard, operating manager of the Puget Sound Power and Light Company. After the fire of 1889, the station was rebuilt, and at one time there were as many as 20 such stations. In 1912, all of the smaller plants merged into the Puget Sound Power and Light Company, which now has a capability of 1.3 million kw, about 200,000 kw of which is used only when there is no rainfall. In 1958, the peak on the system was 1.8 million kw. In closing, the speaker was certain that future engineers will solve the problems ahead just as well as engineers have solved them in the past.

Address by President-Elect J. H. Foote

An inspirational talk was given by President-Elect J. H. Foote on the theme of group dynamic area activity. He pointed out that the AIEE fosters diverse interests in the fields of science and electrical engineering as exemplified in Table VIII which appears on p. 15 of the Board of Directors Report. Based on a survey, the primary interests of members were summarized, as follows: science and electronics, 13%; instrumentation, 5%; communication, 10%; power, 42%; industry, 22%; and general applications, 8%. The first area characteristic was local group interest in street lighting. The speaker advised that area activity should include all of the elements previously mentioned. He defined "dynamic" as that which makes the activities go, and made an appeal that the objectives of AIEE be put into action. In planning activities, Mr. Foote suggested that inquiry of the other fellow's problems be made, and that members should demonstrate a desire to work for others in area activities. He urged the members to show a willingness to teach one another with humility, and recommended that they explore and develop understanding, participation, and service in the work of the AIEE.

Boeing Airplane Company Photo

A SOLAR-POWERED thermoelectric generator for tapping the energy of the sun is put through its paces on the roof of a Boeing Airplane Company building in Seattle, Wash. Developed jointly by Westinghouse engineer N. F. Schuh (*left*) and Boeing engineer R. J. Tallent (*sighting through telescope at the sun*), the generator can convert the energy of the sun into 2.5 watts of power—enough to power a radio transmitter far out in space. The model was demonstrated at the Summer and Pacific General Meeting of the AIEE. Boeing and Westinghouse said the generator may have application in long-mission satellites and manned space vehicles of the future. The concave, highly polished reflector, which resembles a "fun house" mirror, collects the sun's energy and concentrates it on a portion of the cylinder-shaped generator in front of the reflector.

Aerospace Luncheon

The feature of a well-attended luncheon on June 24 was an address, "The Changing Role of the Engineer in Today's Industrial Society," by L. A. Wood, vice-president and general manager of the Pilotless Aircraft Division of Boeing Airplane Company. The speaker first pointed out that, in the early days of aircraft design, structural design principles were borrowed from the civil engineers, but structural dynamics had been so furthered in the aeronautical profession that in recent years it was adequate to explain the dynamic failure of a suspension bridge in a moderate wind. In the early days, electronics in aircraft design was negligible and regarded as an auxiliary; whereas today, in an aerospace transportation system, the vehicle is filled with electronic components and is greatly dependent upon ground-based electronic components all of which must work if the system is to perform its mission.

Mr. Wood further explained that the very rapid pace at which technology has advanced has created a whole new set of management-type problems which demand the attention of today's engineers. It is becoming possible to predict the obsolescence of systems which have not yet reached production and to plan for their orderly replacement. He stated that there was increasing evidence that engineers are turning to business management; the manager of an advanced management program had recently advised the speaker that about 30% of the enrollments in such courses now are engineers, and that the percentage is increasing year by year. The trend toward engineers in management is coming about because it is easier to impart a general understanding of the fundamentals of management to the engineer than to convey to a nonengineer an adequate understanding of today's technically complex projects. In conclusion, it was

CHIEF KIANA, which means Chief of Happiness, was the honorary title given to AIEE President L. F. Hickernell, who was crowned accordingly with traditional Indian headdress after the barbecue at Kiana Lodge of Bainbridge Island during the Summer and Pacific General Meeting.

urged that engineers give more thought to their management tasks.

D. W. Exner presided at the luncheon and introduced the speaker and guests at the head table.

Kiana Potlach Salmon Barbecue

Over 1,000 members took the boat trip on Thursday evening to the potlach salmon barbecue held at Kiana Lodge on Bainbridge Island. The boat ride through Lake Washington Ship Canal and the Government Locks to the salt waters of Puget Sound provided a beautiful scenic trip.

After the barbecue, President Hickernell was made an honorary chief of the Hokaii tribe, with headdress and full tribal ceremonies. He was named Chief Kiana, meaning Chief of Happiness.

Ladies Entertainment

Besides the barbecue and other social events, the ladies had a busy week of entertainment arranged under the chairmanship of Mrs. C. S. Alger. Scheduled events consisted of a color lecture and tea, a guided sight-seeing tour and tea, a champagne luncheon and fashion commentary, and a brunch and flower arrangement demonstration. Hospitality headquarters was open daily for social gatherings and bridge, with coffee served in the morning.

Technical Sessions

Research in the Universities and Research Institutions. R. M. Saunders opened a session on research with a paper written with S. Silver on graduate study and research in electrical engineering at the University of California at Berkeley. In describing the program at the University of California, he stated that teaching and research should not be considered distinct functions, but should go hand in hand. If they are separated, each is likely to become sterile. The faculty, he added, should be the "prime movers" in research efforts.

The subject of high-voltage research in a college laboratory was discussed by L. N. Stone of Oregon State College.

In a paper written with L. M. Beattie and L. M. Maxwell, two of his colleagues at the University of Idaho, G. G. Hespelt described the preliminary design of hydrological data telemetering equipment. This data has long been of interest to water companies, irrigation interests, forestry groups, recreational groups, and Federal agencies concerned with navigation, flood control, and water resource development.

H. J. Dana of Washington State College presented a paper on the design and installation of aviation hazard lights on power-transmission lines across rivers. These lights are strung along the catenary and attached to the cables themselves, identifying the exact location of the cables.

Karl Martinez, of the Boeing Airplane Company, spoke on academic and industrial electrical engineering research for future space vehicles. He presented some challenges in the field of air and space vehicles to academic and research institutional, operational, and environmental parameters and their limits; the new reference for research in the combined operational functions and environment; and a partial interpretation of these factors for research, engineering, and co-ordination with universities and research institutions.

"Electricity for Space Vehicles" was the subject covered in a paper by V. B. Hart, also of Boeing. As vehicle size and period of flight time increase, electric power system problems also increase. These systems for future space vehicles will of necessity become completely static in nature, utilizing static generation, conversion, and utilization equipment, which will guarantee fertile fields in which researchers may expend their efforts.

High-Temperature Equipment. In the first paper of a session sponsored by the Air Transportation Committee, J. J. Pierro of North American Aviation, Inc., reviewed progress on an airborne a-c generation and distribution system for use in 600 F ambients. A large-scale research and development effort unique to the aircraft electrical industry has been initiated by the U. S. Air Force to develop this system. Major problems include fluids, lubricants, rectifiers, and flexible moisture-resistant wire insulation.

J. T. Bateman, General Electric Company, described a solid-rotor a-c generator developed for this high-temperature program.

A paper by W. B. Penn, R. L. Balke, and F. M. Precopio, all of General Electric, outlines some of the problems involved in the design, development, and test of generator insulation systems for high-temperature applications.

Other high-temperature aircraft components discussed were generator bearings by G. D. Bradley, General Electric, and fuses and terminals by W. F. Bonwitt and H. Buttner, Burndy Corporation.

Nucleonics. A session sponsored by the Nucleonics Committee opened with a paper on automatic control of boiling-water reactors, by W. C. Lipinski, A. Hirsch, and C. A. Pesce, Argonne National Laboratory. An automatic power demand control system on a boiling-water reactor increases plant efficiency by operating without waste bypass steam, and extends the core life. It eliminates the necessity for full-time attendance of a reactor operator, who would normally follow large load changes by moving control rods manually.

Preoccupational testing of the General Electric Test Reactor (GETR) was covered in a paper by H. T. Wells and J. O. Arterburn of General Electric's Vallecitos Atomic Laboratory. The prime function of the GETR is the production of high-intensity nuclear activity for irradiation of test specimens in various experimental facilities. The operating tests and physics measurements, made as part of the reactor start-up, were discussed.

R. Sherrard of the General Electric Company, Richland, Wash., discussed reliability and fail-safe requirements of Hanford-type reactor instrument systems. The emphasis was on two types of systems available for monitoring: continuous monitoring and high-speed data acquisition type systems.

A paper by S. P. Giambra of the Bechtel Corporation and A. J. McCrocklin of General Electric, San Jose, Calif., describes "Electrical Cable Penetrations for the Dresden Nuclear Reactor Enclosure." Special gas-tight penetration seal problems for electrical designers are introduced by these enclosures. Some 50 multicircuit seal assemblies have been designed, fabricated, and tested for conductors in the control circuit, power supplies, coaxial cable, and pneumatic control circuits at the Dresden Nuclear Power Plant, being built near Joliet, Ill.

C. J. Dols of the Lawrence Radiation Laboratory, University of California, described the electric system of the bevatron rapid beam ejector or "beam kicker." This device produces the brief pulses of particles required for optimum bubble-chamber photographs.

Electrical Problems in Space. Peter Duyan, Jr., Douglas Aircraft Company, presided at a panel discussion held Wednesday evening under the sponsorship of the Air Transportation Committee. E. C. Wells, Boeing Airplane Company, was moderator. Panel members were C. W. Burrell, Lockheed Aircraft Corporation; M. Riaz, University of Minnesota; R. B. Kershner, John Hopkins University, and W. H. Bostick, Stevens Institute of Technology.

AIEE Future Meetings

AIEE-ASME Engineering Management Conference*
Statler Hilton Hotel
Los Angeles, Calif.
September 17-18, 1959

Nonlinear Magnetics and Magnetic Amplifiers Conference (Exhibits)*
Shoreham Hotel
Washington, D. C.
September 23-25, 1959

AIEE-ASME National Power Conference*
Muehlebach Hotel
Kansas City, Mo.
September 27-October 1, 1959

AIEE-IRE Industrial Electronics Conference*
Mellon Institute
Pittsburgh, Pa.
September 30-October 1, 1959

ECPD 27th Annual Meeting
Wade Park Manor
Cleveland, Ohio
October 5-6, 1959

Fall General Meeting*
Morrison Hotel
Chicago, Ill.
October 11-16, 1959

National Electronics Conference*
Sherman Hotel
Chicago, Ill.
October 12-14, 1959

Fall Textile Conference*
Hotel Charlotte
Charlotte, N. C.
October 15-16, 1959

Machine Tool Conference*
Hotel Sheraton-Cleveland
Cleveland, Ohio
October 19-21, 1959

Mid-America Electronics Conference
Hotel Muehlebach
Kansas City, Mo.
November 3-5, 1959

AIEE-IRE-ISA National Automatic Control Conference
Sheraton Hotel
Dallas, Tex.
November 4-6, 1959

Control Systems Components Conference
Sheraton Hotel
Dallas, Tex.
November 5-6, 1959
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs-Sept. 1)

AIEE-IRE-ISA Electrical Techniques in Medicine and Biology Conference (Exhibits)
Sheraton Hotel
Philadelphia, Pa.
November 10-12, 1959
(Final date for papers—Sept. 15)

Appliance Technical Conference
Biltmore Hotel
Los Angeles, Calif.
November 16, 1959
(Final date for †TP—closed, ‡CP Syn.—Sept. 1, CPMs—Sept. 11)

Magnetism and Magnetic Materials Conference
Sheraton Cadillac Hotel
Detroit, Mich.
November 16-19, 1959
(Final date for †TP—closed, ‡CP Syn.—Sept. 1, CPMs—Sept. 11)

AIEE-IRE-ACM Eastern Joint Computer Conference
Statler Hilton Hotel
Boston, Mass.
December 1-3, 1959

AIEE-NEMA Second National Conference on Application of Electrical Insulation
Shoreham Hotel
Washington, D. C.
December 8-10, 1959
(Final date for †TP—Sept. 9, ‡CP Syn.—Sept. 25, CPMs—October 5)

AIEE-IRE-ASQC Symposium on Reliability and Quality Control
Hotel Statler
Washington, D. C.
January 11-13, 1960
(Abstracts—closed, final papers—Oct. 15)

Winter General Meeting
Hotel Statler
New York, N. Y.
January 31-February 5, 1960
(Final date for †TP—Nov. 12, ‡CP Syn.—Nov. 17, CPMs—Nov. 27)

AIEE-IRE-U of P Transistor and Solid-State Circuits Conference
University of Pennsylvania
Philadelphia, Pa.
February 11-12, 1960.
(Final date for †TP—Nov. 12, ‡CP Syn.—Nov. 27, CPMs—Dec. 8)

EJC Nuclear Congress
New York, N. Y.
April 3-8, 1960

Southwest District Meeting
Shamrock-Hilton Hotel
Houston, Tex.
April 4-6, 1960
(Final date for †TP—Jan. 4, DPMs—Jan. 29)

East Central District Meeting
Daniel Boone Hotel
Charleston, W. Va.
April 12-14, 1960
(Final date for †TP—Jan. 13, DPMs—Feb. 5)

AIEE-ASME-IRE Automatic Techniques Conference
Sheraton-Cleveland Hotel
Cleveland, Ohio
April 18-19, 1960
(Final date for †TP—Jan. 19, ‡CP Syn.—Feb. 2, CPMs—Feb. 12)

Great Lakes District Meeting
Hotel Pfister
Milwaukee, Wis.
April 27-29, 1960
(Final date for †TP—Jan. 28, DPMs—Feb. 22)

North Eastern District Meeting
Sheraton Biltmore Hotel
Providence, R. I.
May 2-4, 1960
(Final date for †TP—Feb. 2, DPMs)—Feb. 26)

AIEE-IRE-ACM Western Joint Computer Conference
Fairmont Hotel
San Francisco, Calif.
May 3-5, 1960
(Final date for †TP—Feb. 3, ‡CP Syn.—Feb. 19, CPMs—Feb. 29)

AIEE-IRE-EIA-WCEMA Electronic Components Conference
Washington, D. C.
May 10-12, 1960
(Final date for †TP—Feb. 10, ‡CP Syn.—Feb. 26, CPMs—March 7)

Farm Electrification Conference
Sheraton-Fontenell Hotel
Omaha, Nebr.
May 10-12, 1960
(Final date for †TP—Feb. 10, ‡CP Syn.—Feb. 26, CPMs—March 7)

Electrical Problems in the Cement Industry Conference
Milwaukee, Wis.
May 17-19, 1960
(Final date for †TP—Feb. 17, ‡CP Syn.—March 4, CPMs—March 14)

*Final date for submitting papers—closed

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Author's Guide*
For a copy, write to E. C. Day AIEE, 33 W. 39th St., New York, N. Y.

Mr. Burrell mentioned that silver peroxide–zinc batteries are now the prime sources of power in space vehicles, with photovoltaic, thermoelectric, thermionic, and nuclear heat sources to come. In addition to the d-c power supplies, present requirements call for 28-volt 400-cycle power achieved through a transistor oscillator-type inverter, as well as a 2-kc system for operation of electronic equipment.

In discussing energy conversion problems, Mr. Riaz pointed out that one of the chief difficulties is the high temperatures encountered. For this reason, considerable effort must be directed toward the development of new and improved materials.

Dr. Bostick discussed some of the various forms of propulsion in space, including the ion engine and plasma motor. In the latter type, plasma speeds of 10^8 centimeters per second have been achieved.

Dr. Kershner characterized as "ridiculous" the spending of vast sums to get man into space before necessary studies with unmanned vehicles are completed. He suggested a reasonable time would be in about 15 years.

Constant-Frequency Variable-Speed Generators. The Air Transportation Committee sponsored a session devoted to generators which supply constant-frequency outputs from variable-speed sources. B. V. Hoard of the Boeing Airplane Company presented a paper on frequency-make-up generators, a system which replaces the conventional generator and mechanical constant-speed drive.

T. B. Owen of Santa Monica, Calif., pointed out some of the methods for obtaining constant frequency from variable-speed sources, including methods now in use as well as those which have been proposed.

A system discussed in a paper by S. E. Rauch, University of California, and L. J. Johnson, Hallamore Electronics Company, produces the desired power without the usual mechanical complications. The electric controls provide simple techniques for synchronizing multiple generators to a common line. The absence of feedback amplifier loops in the system eliminates transient variations in the frequency for load or speed changes.

Constant-speed variable-frequency systems can be built utilizing the p-n-p-n switches now becoming available, as reported in a paper by K. M. Chirgwin and L. J. Stratton, Jack & Heintz, Inc. These systems are competitive in size and total weight with present hydromechanical constant-speed drive and synchronous generator combinations, and have better efficiency, much better frequency regulation, and will likely prove to be more reliable.

Thermoelectric Generators. The session opened with a paper by E. W. Bollmeier, Minnesota Mining and Manufacturing Company, presenting the elementary problems of thermoelectric generation and some of the solutions which have been devised. This paper is scheduled to appear as an article in *Electrical Engineering* within the next few months.

The problem of minimizing the weight of thermoelectric generators in space applications was taken up in a paper by D. L. Kerr and R. L. Gessner, General Electric Company.

A paper by N. F. Schuh of Westinghouse and R. J. Tallent of Boeing presents some of the principles and problems which may be expected in applying solar energy to a thermoelectric generator serving a space vehicle, and describes a small solar-powered thermoelectric generator constructed to study these problems.

The final paper of the session was "Utilization of Thermoelectric Effects," by W. W. Happ and S. R. Hawkins, both of Lockheed Aircraft Corporation.

Rapid Transit. J. C. Price of the General Electric Company presided at a session on rapid transit. The first paper, "Automania Gives Way to Rapid Transit in the Bay Area," was presented by J. C. Beckett of the San Francisco Bay Rapid Transit District. The proposed system will connect five of six densely populated counties in the Bay area and will meet three principal criteria: complete facilities within the cordon of traffic congestion in the Bay area, fares which will not exceed out-of-pocket costs for operating a private automobile over the same general route, and sufficient revenues from fares to meet all operating and maintenance costs.

M. O. Anderberg, Seattle Transit System, reported on an experimental automatic monorail system to be placed in service during the 1961 "Century 21 Exposition," which Seattle is planning with the aid of the State of Washington and the Federal Government. The cars will run from the heart of the retail district to a station on the exposition grounds at top speeds of 60 mph, with a traveling time of about 94 seconds.

C. T. Abbott of Coverdale & Colpitts, consulting engineers, described a study now in progress of the mass transportation needs of Los Angeles. This study is being conducted by an Authority created by the California State Legislature in 1947. Perhaps the most important characteristic of Los Angeles, from a transportation viewpoint, is the large number of people in one geographical location without a correspondingly large concentration of financial activities and corporate headquarters such as characterizes the center of most large metropolitan areas. After careful analysis, four corridors were selected for intensive study as possible rapid transit routes. A total length of 76.5 unduplicated miles was involved. Many details, including type of equipment, train schedules, and fare schedules must be studied before an estimate can be made of the economic feasibility of the system.

Safety. J. V. Grimaldi, General Electric Co., in his paper, 'Hazard Control in Electrical Testing," described the safety manual intended only for department managers. Its main objective is to present a minimum of data for safety and standards of testing equipment, and to show those responsible for these measures how to recognize and eliminate dangerous points.

A conference paper that evoked a great deal of discussion was given by Prof. C. F. Dalziel, University of California, entitled, "120-Volt 3-Wire Receptacles and their Attachment Plugs." The speaker showed samples of receptacles and plugs and explained how easy it is to have them wired incorrectly because of the nonuniformity of wiring instructions. It was brought out in the discussion that there is no uniform method of marking or indicating which of the connections should go to the hot side of the line, and that this lack increases the danger angle.

A motion picture by A. Gordon, Children's Hospital, Los Angeles, showed the latest method of mouth-to-mouth resusci-

AIEE President-elect J. H. Foote (*left*), F. D. Robbins, University of Washington; (*center*), and outgoing President L. F. Hickernell (*right*) with first prize winners of the District Student Prize Papers Contests. The first prize winners received a trip to the Summer and Pacific General Meeting as part of their prize.

Courtesy F. J. McGrail

cation. It was brought out that this way of treating electric shock was better than any of the older methods and much less tiring on the operator

Research. Three groups of panelists considered the topic of Electrical Research in the West. The first one discussed fundamental research, in the course of which Frank Noakes, University of British Columbia, stated that research is an essential to universities and to the best interest of their communities. He described the various projects under way in his college and stated that they are trying to find the philosophy behind the idea. It was brought out in the discussion that research does not detract from a professor's teaching ability.

In another group of speakers, F. L. Singer, Bell Telephone Laboratories, said that communications was a far greater field for research than any other. He gave as an example the transistor, which has gone far in the past 10 years, but about which there is much that is unknown. Solid-state devices have opened more fields than have vacuum tubes; for instance, electronic switching, long-distance pulse transmission, machine-to-machine communication, etc.

E. D. Cook, General Electric Company, brought out that, as we progress, we need more sources of power and that we need a completeness of knowledge about sources which we already have. Research means knowledge, and that is important in itself. He stated that all too often the economic aspects of research are neglected and that, above all, we need to get busy on fundamental concepts.

Karl Martinez, Boeing Airplane Company, said that more work was needed on energy conversion in vehicular research. The transitions from earth to space and return are being studied now, but we do not know how to solve the problems which are encountered.

Space. Two of the sessions sponsored by the Air Transportation Committee were devoted to power in outer space and the design of the means to supply it. In the first, the ion propulsion system for space flight was considered in two papers.

A. E. Lennert, The Martin Company, gave "Practical Considerations of an Ion Propulsion System," in which he compared the various types of rocket propellants: chemical, photon, solar, radioisotope, and plasma with the ion system.

Mr. Cobb, Mr. Shook, and Mr. Cutler, Lockheed Aircraft Company, presented "A Nuclear Ionic System for Space Flight," in which they considered the development of an advanced power supply and its incorporation into a space ship. They combined the design of a high-temperature reactor with a proposed thermionic power converter, which acts as a heat sink, radiating waste power to outer space. The electric power obtained is then applied to an ion motor using the tungsten-cesium surface ionization principle.

In the session devoted to Solar Power in Space, the four papers dealt with the design of secondary power supplies dependent upon the sun for their source of power. E. F. Casey and G. Street, Jr., General Electric Company, in their paper," A Thermionic Power Supply using Solar Heat for Space Application," predicted that silicon solar cells will probably become the work-horse power source in the immediate future for space craft. Batteries can be used in very short duration space exploration and would be impractical for months of flight because of their weight. The feasibility of both the vacuum and the high-pressure types of thermionic elements have been demonstrated and show conversion efficiencies between 1.5 and 9.2%.

In the session in which the testing of vehicles in flight was considered, J. E. Regar, General Electric Company, talked about the instrumentation requirements for a long-range re-entry vehicle. In discussing a hypothetical system for preflight testing, he stated that the following were the environments which had to be considered: vibration, altitude control, arming and fusing, and perhaps the most important of all, re-entry heating. He also discussed the difficulties encountered in obtaining instruments for measuring space environments.

D. B. Hatmaker, Lockheed Aircraft Corporation, presented a very interesting paper, "Instrumentation for Research on Human Performance." It is the purpose of the Human Factors Laboratory to develop criteria by which designers of air- and spacecraft may be guided in the efficient use of people and machines in a complex system. This testing system explores and analyzes man's ability to perform, and his psycho-physiological reactions to typical tasks assigned to a human operator in the air.

Section Delegates Meet during Summer and Pacific General Meeting

THE AIEE Section Delegates Conference was held Tuesday, June 23, during the 1959 Summer and Pacific General Meeting and Air Transportation Conference at Seattle, Wash. H. H. Sheppard, chairman of the Sections Committee, presided.

Mr. Sheppard opened the session with the introduction of N. S. Hibshman, AIEE secretary; J. J. Anderson, secretary, Administration Department; E. C. Day, assistant secretary, technical papers; W. E. Scholz, secretary, Sections Committee, and G. D. Jorgensen, delegate, Seattle Section.

He then commented on two items of interest to Section delegates. The first was the approval of the revised Constitution; the second was the creation since the 1958 Summer General Meeting of seven new Subsections: Panama City, Central Florida, Alaska, Walla Walla (Wash.), Orange County (Calif.), Newark (Ohio), and San Joaquin (Calif.).

President's Report to Delegates

AIEE President L. F. Hickernell spoke on Institute membership and finances. He discussed briefly the problem of membership growth, which he had covered at length at the Section Delegates Conference at the Winter General Meeting in New York, N. Y., on February 3, 1959. He stated that there is no standard solution applicable to all sizes and types of Sections. Each must be studied from its own

SHOWN during presentation of Section Growth Awards during Section Delegates Conference are *(left to right)*: W. M. Edmunds, Washington (D. C.) Section, second prize, Larger-than-Average Section; W. E. Scholz, secretary, Sections Committee; J. J. Berry, Jacksonville Section, first prize, Smaller-than-Average Section; J. E. Martin, Denver Section, first prize, Larger-than-Average Section; H. H. Sheppard, chairman, Sections Committee; and A. J. Carter, Hamilton Section, second prize, Smaller-than-Average Section.

AIEE Memphis Section

AT THE ANNUAL DINNER-DANCE of the Memphis Section, officers for 1959-60 were elected. W. L. Wood, Jr. (*right*) Okonite Cable Company, was elected chairman. He receives the Section gavel from A. H. Beasley (*left*), outgoing chairman. Elected vice-chairman was J. F. Fletcher. The Secretary will be L. E. Cox, Jr., and treasurer, Y. M. Quinn, Jr. Three directors elected were L. B. Allen, W. B. Stephenson, and J. J. McCullough.

geographical viewpoint and on the basis of local conditions.

President Hickernell also summarized some of the important aspects of Institute finances. He pointed out the increase of expenses from $15 to $32 per member since 1934. Among sources of income, the largest is from dues and fees, and the second largest is from advertising. Publications account for about half the Institute expenditures. The 1958-59 deficit is primarily the result of three factors: (1) decrease in advertising revenue because of loss of recruitment advertising and decline in space sales during the business recession; (2) decrease in registration fees and income from Special Technical Conferences; and (3) increase in publication expense, mainly because of the sharp increase in the number of Transactions pages published.

To reduce net cost, the Board of Directors was forced to discontinue a free subscription to a bimonthly publication of the member's choice, and to impose an annual charge of $2.50. In addition, the Publications and Technical Operations Departments have imposed a limit of 20 pages per paper (in preprint form), and a budget of 500 papers to be published in 1959-60.

The figures for entrance and transfer fee rebates to the Sections indicate that, to date, these rebates have not operated effectively as incentives for grade transfer.

United Engineering Center

Past President W. J. Barrett was then introduced. He commented briefly on the progress in the Institute during the past year. He went on to stress that we are living in a technological age, and that the next war is being fought right now with the brains of engineers and scientists. The job which has been placed in our hands is tremendously important and serious.

Because our society is so complex, teamwork and organization are essential. For this reason, professional organizations play an extremely important role.

One of the basic needs of the engineering societies is a place to work. The present building is completely inadequate for the requirements of the engineering profession today.

Mr. Barrett presented slides showing the Engineering Societies' Building on 39th St., New York City, as it looked shortly after construction and as it looks today, 50-odd years later. He emphasized the crowding by other buildings, the traffic problem, and the lack of provision for expansion.

He then showed slides of architects' drawings of the new United Engineering Center, to be built at United Nations Plaza in New York City. Features include an attractive setting with no possibility of crowding by other buildings, and, most important, adequate room in which to work. The first floor will contain meeting rooms and an exhibit hall. The second floor will house the Engineering Societies Library as well as the facilities of the Engineering Index. At the north end of the building, at street level but under the first floor, will be a cafeteria for employees and visitors, as well as kitchen and storage facilities.

Rising above the second floor will be a tower with 16 floors of usable space plus a penthouse. It is contemplated that 14 of these floors will be used immediately for office space, with the other two floors reserved for future use. Provision has been made also for future addition to the building at the rear (north) of the tower.

The Turner Construction Company has been chosen as the contractor. The working drawings are scheduled to be completed by the end of August, and it is anticipated that the subcontracts will be awarded October 1. Ground breaking is planned for October 15. It is hoped that the building will be occupied during the early part of 1961.

Of the $11,750,000 cost, $2,750,000 was available from the United Engineering Trustees, leaving $9 million to be raised. Of this, industry set out to raise $5.5 million, and the individual societies, through Member Gifts Campaigns, the remaining $3.5 million. The AIEE goal is $900,000.

In closing, Mr. Barrett stressed that the success of the campaign depends upon individual contacts of members at the Section level.

Member Gifts Campaign

W. E. Scholz, secretary of the AIEE Member Gifts Campaign Committee, then reviewed the progress of the campaign. To date, $773,991 had been received in AIEE pledges and contributions, or approximately 86% of quota. These pledges and contributions were received from slightly more than 20,000 members. Section reports indicate that many members have yet to be contacted. Mr. Scholz stated that the campaign will be a success if every member is contacted. A total of 21 Sections have exceeded their quotas. Among the leaders, with percentages of quota attained, are: Dayton, 182; Schenectady, 145; Sacramento, 131; Pittsburgh, 130; Corpus Christi, 127; Mansfield, 124; and Richland, 121.

Funds also have been contributed by the Sections themselves, as well as through their Student Branches and Ladies' Auxiliaries. Among these are $15,000 from the New York Section, $1,500 from the Florida West Coast Section, $1,248 from the Boston Section, $1,235 from the Maryland Section, $1,200 from the Los Angeles Section, $1,000 each from the San Francisco and Connecticut Sections, $580 from the Lehigh Valley Section, and $500 each from the Sacramento and Lynn Sections. During the discussion, a check for $557 was presented from the North Carolina Section by Delegate M. J. Mulhern.

Redistricting

The subject of redistricting was reviewed by C. T. Pearce, vice-chairman, Administration Department. Effective August 1, 1959, District, No. 14, the Allegheny–Ohio Valley District, will come into being. It will take in parts of Western Pennsylvania and Eastern Ohio,—in all, four Sections from District No. 2 and five Sections from District No. 11.

Also planned, effective August 1, 1960, is the splitting of present District No. 7 (South West District) into District No. 7 (Mid-America District) and District No. 15 (South West District). The Mid-America District would comprise the Arkansas, Kansas City, Oklahoma City, St. Louis, Tulsa, and Wichita Sections.

Section Growth Awards

The Section Growth Awards, for largest percentage gain in membership during the past year, were presented by Mr. Sheppard. These awards are made in two categories to the Smaller-than-Average Section and the Larger-than-Average Section. In each category, the first prize is a gavel and the second prize, a certificate. For the Smaller-than-Average Section, the winners were Jacksonville, first prize, and Hamilton, second prize; runners-up were Nebraska, Corpus Christi, and Miami. For the Larger-than-Average Section, first prize was awarded to Denver and second prize to Washington, D. C.; runners-up were North Carolina, San Francisco, and Boston.

Institute Finances

W. A. Clark, chairman of the Finance Committee, presented a brief summary of Institute finances. The following expense and income figures were presented:

Institute Finances

Year	Expense	Income	Reserve
1957-58 (Actual)	$1,674,563	$1,759,876	$ 85,313
1958-59 (Budgeted)	1,849,443	1,771,180	—78,263
1958-59 (Actual)	1,743,856	1,677,922	—65,934
1959-60 (Proposed Budget)	1,936,969	1,719,500	—217,469
1959-60 (Revised Budget)	1,820,349	1,792,400	—27,949

Much of the deficit, as stated earlier by President Hickernell, was the result of decrease in advertising revenue and the increase in number of Transactions pages published.

Among the proposed remedies for cutting expenses are: cutbacks in public relations operations; reduction of District executive meetings from two to one a year, with resultant decrease in travel expenses; changes in rates of rebates to Sections for membership and transfers; change of dues ruling so that Associate Members over 30 would be assessed the same dues as Members; reduction in stationery expense through reduction in number of Committee letterheads; a 25% increase in the price of preprints to members and nonmembers; postponement of plans for a student quarterly; an increase in price to members of first bimonthly to $5; an increase in registration fees at General Meetings from $5 to $6 for members and from $8 to $10 for nonmembers, and at District Meetings from $3 to $5 for members and from $5 to $7 for nonmembers; addition of registration fees for women; imposing a minimum fee of $5 for Technical Conferences; simplification of election ballot procedures, and revision of travel allowance policy on Student Branches.

Admission and Advancement

Charles Concordia, chairman, Transfers Committee, reported results of the replies to a letter sent to all Section chairmen requesting information on transfer requirements and procedures. Many worthwhile suggestions and comments were received from the 76 Sections which have replied to date.

On transferral from Member to Fellow grade, 51 considered that the present requirements were just right, 4 that they were too lenient, 12 that they were too stringent, and 9 had no comment (which might be interpreted that these 9 Sections were also satisfied with the present requirements). For the 12 cited, the aspects considered too stringent were: age or years in Member grade (5), number of Fellow references (3), technical qualifications (3), and lack of opportunity to apply personally (1).

On transferral from Associate Member to Member grade, 71 considered that the present requirements were just right, 1 that they were too lenient, 2 that they were too stringent, and 2 had no comment.

R. K. Fairley, chairman of the Membership Committee, pointed out some of the essentials for successful membership campaigns. The most important consideration is that each Section have a good active Membership Committee chairman. The personal contact approach is by far the most effective means for gaining new members. November 1959 has been designated "Membership Month," and a concerted drive is being planned to increase the membership in each Section by at least 10%.

Educational Activities

D. T. Michael, vice-chairman, Membership Committee, reported on the overwhelming success of the special study group courses offered by the New York, Boston, Cincinnati, Los Angeles, and Michigan Sections, and the Newark Subsection of the Columbus Section. He stated that the courses are attended mainly by non-AIEE members and provide an excellent opportunity for gaining new members. He urged all Sections to investigate the possibility of conducting such courses.

National Technical Committees

Technical Operations Department Chairman Hendley Blackmon outlined some of the problems involved in obtaining good Technical Committee personnel. The hardest job, he said, is that of finding new members who are qualified and willing to work. It is vital that the committees receive good recommendations from the Sections. Another important factor in choosing an individual is his availability for meetings.

Points to remember in choosing candidates: hunt for likely candidates all through the year; recommend only those people you are sure are of the highest caliber; recommend bright young comers for subcommittees; recommend only AIEE members for committees (this is not a requirement for subcommittees); and make no commitments to proposed candidates.

Section Activities

The Conference closed with a brief discussion of Section activities.

C. J. Grimm, chairman of the Student Branches Committee, cited the increase in co-operation between the Sections and Student Branches over the past few years. He also discussed a program for contacting graduates before commencement by means of cards, in order to obtain names of their prospective employers and addresses. These cards are forwarded to the appropriate Sections and will make it possible for the Sections to get in touch with the graduates concerning membership in the Institute.

R. C. Mayer, Jr., of Raymond C. Mayer & Associates briefly described the pamphlets and material available to the Sections for public relations and recruitment purposes, with the emphasis on special 75th Anniversary material which has been prepared.

In closing, Chairman Sheppard stressed the importance of turning in Section meeting reports promptly.

Maryland Section Women's Auxiliary

OFFICERS of the Women's Auxiliary of the AIEE Maryland Section are *(sitting, left to right)*: Mrs. Ronald Dumont, treasurer; Mrs. Edward Kaminski, chairman; Mrs. Anthony Schettler, vice-chairman; *(standing, left to right)*: Mrs. J. M. Graff, recording secretary; and Mrs. J. W. Drenning, corresponding secretary. The Maryland Section's Women's Auxiliary was founded 2 years ago and now has over 100 members. The group has a project to underwrite a scholarship for an electrical engineering student at Johns Hopkins University.

Blakeslee-Lane, Inc., Photography

Board of Directors Meeting June 26, 1959, Seattle, Wash.

IT IS THE CUSTOM, at the June meeting of the Board of Directors, to invite all of the new members whose election for the coming year has been announced at the Annual Meeting a few days earlier. Of the possible 47 old and new members, 42 were present in Seattle on June 26, the last day of the 1959 Summer and Pacific General Meeting. In a 9 a.m. to 5 p.m. session, the Board considered 75 separate items of business and voted on 47 questions. Some of the more important actions are briefly summarized as follows:

Finances

Approved the Auditor's report which appears on pp. 858-59 of the August 1959 issue of *Electrical Engineering;* took some satisfaction from the fact that the deficit of $66,000 was $13,000 less than budgeted and $109,000 less than predicted in February (See *Electrical Engineering* p. 367). The book value of reserve funds was found to be $1,200,000.

Organization

Major changes were made in the organization chart. The Admissions and Advancements Department was discontinued. The Administration Department was expanded and renamed the General Administration Department (GAD). The new GAD will include the vice-presidents, and the chairmen of the Sections, Student Branches, Public Relations, Membership, and Transfers Committees. The Board of Examiners was assigned to the Professional Development and Recognition Department. The Advisory Committee on Honors was added to those reporting directly to the Board of Directors. Other departments remain unchanged.

Constitution and Bylaws

The adoption of the new constitution was announced at the Annual Meeting on Monday, June 22. Streamlining the constitution required the transfer of much material to the bylaws. The Board voted this transfer without intent to modify the policy or regulations involved. The Constitution and Bylaws Committee will undertake to edit and integrate this material into a modernized set of bylaws as soon as possible. There were, however, several substantial bylaw amendments voted:

1. Section allotments will, in the future, be based on $1.30 for Fellows and Members and $1.00 for all other dues-paying members in the Section territory.
2. Reduction of dues for the first 6 years of membership will, in the future, be limited to those under age 30.
3. Future elections of institute officers will require a membership ballot only in case there is a contest resulting from more than one nomination for an office.

New Districts

A new district, the Allegheny–Ohio Valley District No. 14, was created by taking four Sections from the eastern part of District No. 11 and five from the western half of District No. 2. Effective August 1, 1959, Johnstown, Pittsburgh, Ridgeway, and Sharon Sections, formerly of District No. 2; and Akron, Canton, Cleveland, Ohio Valley, and West Virginia Sections, from District No. 11, with all of their associated territories, Branches, and Subsections will be joined together and henceforth known as District No. 14. W. H. Chase, former vice-president from District No. 11, was elected to head District No. 14 for the 2-year term beginning August 1, 1959. A. W. Rauth of Jackson, Mich., was elected to complete the term as vice-president from District No. 11.

The Board also authorized the splitting of District No. 7, effective August 1, 1960. The new District thus created will be known as the Southwest District No. 15, to include the Beaumont, Corpus Christi, El Paso, Houston, Mexico, New Mexico, North Texas, Pan Handle Plains, Shreveport, and South Texas Sections. District No. 7, then to be known as the Mid-America District, will include the Arkansas, Kansas City, Oklahoma City, St. Louis, Tulsa, and Wichita Sections. The District No. 7 Executive Committee will choose the vice-president to represent District No. 15 for nomination and election by the usual process in the spring of 1960.

Student Publication

The Board approved and appropriated funds for the inauguration in September of a new student publication to be sent periodically to the student members of AIEE and other electrical engineering students, in the colleges where AIEE has Branches. This will be in addition to the monthly magazine, *Electrical Engineering,* and other publication privileges now enjoyed by student members.

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until September 29. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, AIEE, 33 W. 39th St., New York 18, N. Y., on or before September 29.

58-89 **Application of Switching Transistors and Saturable Reactors in a High-Performance Servo.** *F. B. Cox, P. R. Johannessen*

58-186 **A One-Watt Solar Power Plant.** *D. H. Smith*

58-1182 **Status of Sampled-Data Systems.** *E. I. Jury*

59-116 **Study of Thermal Deterioration of Kraft Pulps Using a Mass Spectrometer.** *Y. Saito, T. Hino*

59-178 **Improved Systems for Recording Conductor Vibration.** *C. B. Rawlins, J. R. Harvey*

59-182 **Considerations Pertaining to the Design of an Electronic Telephone Switching System.** *B. Brightman, M. P. Tubinis*

59-187 **Twenty Years' Experience with Outdoor Single-Tank Oil Circuit Breakers.** *S. Clare, W. O. Rowan*

59-210 **Transmission Aspects of an Electronic Switchboard Employing Time Division Multiplexing.** *J. C. Perkins*

59-505 **Deep Ground Beds for Cathodic Protection.** *S. E. Trouard, E. A. Wagner, Jr.*

59-509 **A Transportation System for Carrier Systems Up to 156 Kc.** *Bess M. Kirkland*

59-511 **The Use of D-C Overpotential Testing as a Maintenance Tool in the Industrial Plant.** *W. A. Weddendorf*

59-793 **Design of Polyethylene-Insulated Multipair Telephone Cable.** *A. S. Windeler*

59-492 **Multiple-Unit Operation of Diesel and Electric Locomtives on the Milwaukee Road.** *Laurence Wylie*

Preprints may be purchased at 50¢ each to members, $1.00 to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 W. 39th St., New York 18, N. Y.

Fellows Elected

Some 27 Members, recommended by the Board of Examiners, were elected to the grade of Fellow of the Institute. Pictures and brief biographical sketches available appear elsewhere in this issue of *Electrical Engineering*. Others will appear subsequently.

Honorary Member

E. B. Robertson (M '24, F '45), president of the AIEE in 1953–54, was elected an honorary member of the Institute.

European Universities Recognized

A total of 12 leading universities and technical colleges in Europe were approved by the Board of Directors. Their graduates will be accepted as voting members of the Institute on the same basis as graduates of Engineers' Council for Professional Development accredited curricula in the United States.

Next Meeting

The Board will meet next in Chicago, Ill., during the 1959 Fall General Meeting on Friday, October 16.

Forum of Technical Committee Chairmen

THE 20TH FORUM of Technical Committee Chairmen was held on Wednesday June 24, in the Olympic Hotel, Seattle, Wash., during the Summer and Pacific General Meeting. Valuable information for the incoming chairmen was given in four prepared talks on the following subjects: (1) Institute meetings and papers, (2) AIEE-Institute of Radio Engineers (IRE) relationships, (3) how West Coast members can help advance the Institute's technical work, and (4) Institute activities and organization. The meeting was called to order by Hendley Blackmon, chairman of the Technical Operations Department (TOD), and the Forum was opened by President L. F. Hickernell, who gave the first talk.

Institute Meetings and Papers

Valuable data were presented by President Hickernell on meetings and papers since the time of the first meeting, held in Philadelphia, Pa., October 7-8, 1884, to the present. From prepared charts and tables of attendance at meetings and the number of papers presented, President Hickernell analyzed, on the basis of attendance per paper, the statistics for all of the General Meetings and District Meetings for the period from 1946-47 until 1958-59. Special Technical Conferences, which were AIEE sponsored and those which were jointly sponsored, were analyzed from the time of their inauguration in 1947-48 to 1958-59. Attendance per paper was considered by the speaker to be the best yardstick yet devised for forecasting attendance and evaluating performance, provided suitable correction factors are applied for location and business conditions. District Meetings in particular were found to be very sensitive to these factors. During the period of analysis, the membership increased from 26,470 to 53,827, or more than doubled. In general, while the number of papers over the 11-year period for the General Meetings increased over threefold, the attendance per paper decreased from 17.0 to 10.7. For the District Meetings, the number of papers presented had increased fivefold but the attendance per paper had decreased 19.8 to 8.1. For the AIEE Special Technical Conferences, while the number of papers presented increased 3.8 times, the attendance per paper increased from 12.5 to a high of 22.5 in 1952-53, and gradually decreased to 18.7. In respect to the jointly sponsored Special Technical Conferences, while the number of papers presented was increased twelvefold, the attendance per paper increased from 7.6 to a high of 28.3 in 1952-53 and then declined rapidly to 17.8. In conclusion, President Hickernell explained that the data were presented only to try to clarify the problem; it was the function of a separate committee under TOD, which has the matter under study, to find a solution. As observations for consideration, he pointed out that currently, Chicago has two large annual meetings, the National Electronics Conference and the American Power Conference. If several of the Technical Divisions could participate more actively in those annual events, it might be possible to eliminate the Fall General Meeting.

It was suggested that within a few years, there might be 15 Districts of which 10 might wish to continue District Meetings or hold joint District Meetings. A pattern should be established which would avoid more than five in one administrative year and, with the Fall General Meeting discontinued, some of the District Meetings could be returned to September and November. In some areas, Technical Divisions and Districts might hold joint meetings.

Some Special Technical Conferences now held as annual conferences might be held biennially. In some areas, perhaps two or more of these conferences might be combined profitably.

AIEE-IRE Relationships

The subject of relationships between AIEE and IRE was discussed by E. I. Green, who pointed out that this matter has been receiving attention for a number of years and as a result, close co-operative relationships have been established in a number of areas; for example, on student branches, on technical conferences, etc. Recently, IRE approached AIEE suggesting that a joint study be made of the possibility of achieving increased co-operation through encouragement of joint technical committees, joint student branches, joint section meetings, and reciprocal entrance to equivalent membership grades. This proposal led to the establishment of a subcommittee of the Planning and Coordination Committee assigned to review AIEE-IRE relationships.

The subcommittee concluded that the over-all problem of AIEE-IRE interrelationships is rather complex and full understanding requires considerable familiarity with the operations of the two societies. This matter, moreover, is related to problems of AIEE organization and activities, which are under study as reported by another forum speaker, Dean Lewis, and is also related to problems of unity in the engineering profession. The majority opinion in AIEE favors across-the-board co-operation with IRE on a full partnership basis, looking toward an eventual unified electronic and electrical engineering association.

Subsequent to the Forum meeting, the AIEE Board of Directors accepted the IRE proposal to study ways of obtaining closer co-operation between the two societies.

How West Coast Members Can Participate in Technical Activities

Ways in which the West Coast members can help advance the Institute's technical work were outlined by C. T. Hatcher, vice-chairman, TOD. The speaker advocated activity in a technical group in the member's local Section, participation in the work of a national technical committee, and working through established TOD channels. To become active in a technical group, Mr. Hatcher suggested that if such a group is nonexistent for a particular subject, the member should request the Section to investigate with the intention of forming a group.

In regard to participation in national technical committee work, a member, if he feels that he is qualified and willing to work, should send to the chairman of the technical committee in February a short summary of his qualifications or arrange for the Section chairman, company, or an authority in his field to sponsor him to the technical committee chairman. If it should be impossible to become affiliated with the main technical committee, members on the West Coast should try to be appointed to a task group, because most of the work is carried on by correspondence. Participation in specialized projects of a national technical organization results in a feeling of satisfaction and achievement.

In recent years, the Divisions and committees have realized the desirability of increasing participation on the part of West Coast members. The chairman of TOD has requested all Division chairmen to adjust Division structures to meet the need for developing papers for Pacific General Meetings. It was also suggested that in addition to the new West Coast Subcommittee, established by the Administrative Committee at the direction of TOD, the Divisions should have West Coast committees to cover their respective fields. If a particular committee does not have a West Coast subcommittee, a communication should be addressed to the national committee chairman suggesting

formation of such a subcommittee listing a number of possible members and offering to help organize the new subcommittee.

With respect to working through established TOD channels, C. T. Hatcher explained that in each District, there is an officially appointed TOD representative; these representatives form a subcommittee of TOD. Any member who has a basic idea that cuts across a number of Technical Divisions should bring the idea to the attention of the TOD representative who will present it to the department. In addition, TOD has a West Coast Subcommittee which serves as an office to collect, correlate, and reflect West Coast views on any TOD matters of major interest with the intention of guiding, stimulating, and steadily improving the technical caliber of the Pacific General Meetings.

Institute Activities and Organization

A preliminary report of the Special Task Force appointed by the Board of Directors to study ways and means of improving the organization to keep pace with the rapidly advancing art and to meet the needs of younger members was given by Director W. A. Lewis, chairman of the Special Task Force. The preliminary report advocated the establishment of national technical groups, a new activities committee, greater flexibility in publications, memberships available in technical groups, Section representatives, and broader representation on the Board of Directors.

It was stated that national technical groups should be established as soon as 100 or more members have indicated interest in the subject. The activities of each national technical group would be planned and directed by the corresponding technical committee in its area.

To keep up with new developments in the field, a new activities committee or division was proposed. This committee or division could function under TOD and consider all suggestions for new technical activities or changes in present activities submitted by members. It would have authority to establish a temporary technical committee under its own supervision or initiate a new activity when necessary. Technical activities would not remain permanently under the jurisdiction of the new activities committee, but, as soon as they were reasonably well established, they would be transferred to one of the existing Divisions. The primary purpose in recommending the establishment of the new activities committee is to provide a separation between responsibility for operating an existing organization and for establishing major modifications in the structure of the organization to meet new needs.

To provide greater flexibility in publications, the Special Task Force recommended authorizing each Division to establish its own bimonthly type of publication, and possibly permitting a technical group to set up a separate publication. Permission for a separate publication would be granted only when a technical group and its members could and would accept the financial and technical responsibility for the proper conduct of the publication in a manner which would coordinate with the over-all activities of the Institute. In developing these publications, effort would be made to minimize duplication in such a way that all members of the Institute could receive the annual *Transactions* involving all Transactions papers without prohibitive increase in cost. In some cases, desirable features of the plan might be achieved by including additional material in the bimonthly proceedings, if so arranged that the material of transitory interest would not be included in the bound *Transactions*. Technical groups would be authorized to make arrangements for their members to subscribe in advance for preprints, committee reports, and other matter sponsored by the group. With such a plan, it is believed that major departures from the existing publication policy would be minimized and the advantages of publication by Division grouping retained. However, technical groups would still have the privilege of developing a separate publication, if convinced that such a publication was essential for the proper development of the technical activity as a part of the entire activity of the Institute and if such groups were prepared to support the separate publication.

Sections would be given the opportunity to select an official representative on each technical group organized. The Special Task Force also recommended that a way should be developed immediately whereby the nomination of Institute directors to represent the various areas of technical activity would be possible.

After the presentations, many views were expressed by officers, chairmen of Departments, and committee members, including the experiences gained from expansion in the Los Angeles and San Francisco Sections. The need for more advance long-term planning was recognized and views were expressed that the present committees who are chiefly concerned with immediate operating problems are not in a favorable position for long-range planning work. Enthusiasm was expressed for the work done by the technical committees and Divisions and ways were suggested to take back ideas that originated in the Forum.

Papers Presented at the 1959 AIEE Summer and Pacific General Meeting

A LISTING of the papers presented at the Institute's 1959 Summer and Pacific General Meeting and Air Transportation Conference, June 21-26, Seattle, Wash., follows. Copies of numbered papers only are available to members for 50¢ each and to nonmembers for $1.00 each. Send order and remittance to: AIEE Order Department, 33 W. 39 St., New York 18, N. Y. Papers marked CP* have not been printed by the Institute.

Chemical Industry

CP.* An Arabo-Galactan Industry for the Pacific Northwest. *M. Adams*, State College of Washington.

CP59-989. Pozzolan Production at the Priest River Dam. *E. N. Klemgard*, State College of Washington; *A. E. Strom*, Grant County PUD.

59-820. Trends in Ground Bed Design for Cathodic Protection of Underground Structures. *A. P. Landry, I. N. Howell*, Southern Bell Tel. & Tel. Co.

59-505. Deep Ground Beds for Cathodic Protection. *S. E. Trouard, E. A. Wagner, Jr.*, New Orleans Public Service, Inc.

59-821. Cathodic Protection Applications at the Hanford Works. *C. S. Bucholz*, General Electric Co.

CP.* Theory and Practice of Paint Application. *G. Martin*, Parker Paint Mfg. Co., Inc.

Insulated Conductors

59-496. A 35-Kv Polyethylene Insulated Cable Installation. *G. J. Crowdes*, Simplex Wire and Cable Co.

CP59-972. Operating Experience with Thermoplastic Insulated Wire and Cable in Chemical Plants—Progress Report No. 2. *M. M. Gilbert*, E. I. du Pont de Nemours and Co. (Inc.)

CP59-892. The Texada Island Submarine Cable Crossing. *P. J. Croft*, British Columbia Power Commission.

Rotating Machinery

57-130. A New Stator Coil Transposition for Large Machines. *W. L. Ringland, L. T. Rosenberg*, Allis-Chalmers Mfg. Co.

59-683. The Polyphase Induction Machine with Solid Iron Rotor. *N. Kesavamurthy, P. K. Rajagopalan*, Indian Institute of Technology.

59-810. Constant Frequency A-C Power Using Variable Speed Generation. *R. D. Jessee*, Westinghouse Electric Corp.; *W. J. Spaven*, Walter Kidde & Co., Inc.

Basic Sciences

59-917. Mixed Transcendental and Polynomial Transforms. *O. J. M. Smith*, University of California.

CP59-918. The Analysis of Sampled-Data Systems with Nonlinear Elements. *R. E. Andeen*, Sperry Rand Corp.

CP.* Analysis of Pulse Duration Sampled-Data Systems with Linear Elements *R. E. Andeen*, Sperry Rand Corp.

59-919. Recurrence Relations in the Solution of a Certain Class of Nonlinear Systems. *A. A. Wolf*, University of Pennsylvania.

Research in the Universities and Research Institutions

CP59-1007. Graduate Study and Research in Electrical Engineering at the University of California. *S. Silver, R. M. Saunders*, University of California.

CP59-882. High-Voltage Research in a College Laboratory. *L. N. Stone*, Oregon State College.

CP59-936. Preliminary Design of Hydrological Data Telemetering Equipment. *L. A. Beattie, G. G. Hespelt, L. M. Maxwell*, University of Idaho.

CP59-884. An Aviation Hazard Light for Mid-Span Operation on Power Transmission Lines. *H. J. Dana*, State College of Washington.

CP59-1050. Academic and Industrial Electrical Research for Future Space Vehicles. *Karl Martinez*, Boeing Airplane Co.

CP.* Electricity for Space Vehicles. *V. Hart*, Boeing Airplane Co.

Safety

CP59-975. Hazard Control in Electrical Testing. *J. V. Grimaldi*, General Electric Co.

CP59-923. Electrical Safety Regulations in the United States, Canada, and Europe. *L. D. Price, H. P. Michener*, National Electrical Manufacturers Association.

CP59-940. 120-Volt Three-Wire Receptacles and their Attachment Plugs. *C. F. Dalziel*, University of California.

CP.* Mouth-to-Mouth Resuscitation (Film). *A. Gordon*, Children's Hospital, Los Angeles, Calif.

Domestic and Commercial Applications

CP59-1022. The 1959 National Electrical Code. *H. H. Watson*, General Electric Co.

CP59-999. The Impact of Electric Heating on a Public Utility. *D. H. Ohney*, Washington Water Power Co.

CP59-948. A Control-Free Earth Heat Pump. *R. A. Balch*, Line Materials Industries.

CP.* Trials and Tribulations of a Heat Pump. *K. M. Wood*, Wood & Landerholm.

Chemical Industry

CP59-984. The Pacific Northwest Chlorine-Caustic Industry. *J. Judy*, Hooker Chemical Corp.

CP.* New Products from the Forests. *M. D. Strickler*, State College of Washington.

59-822. High-Speed Restarting and Protection of Large Synchronous Motors. *C. L. Phillips*, General Electric Co.; *M. H. Yuen*, Bechtel Corp.

CP59-891. High-Speed Reclosing of Circuit Breakers on Systems Utilizing Synchronous Motors. *R. V. Shepherd, W. R. Morton*, General Electric Co.

59-823. Battery Impedance: Farads, Milliohms, Microhenries. *E. A. Willihnganz, P. Rohner*, C&D Batteries, Inc.

Power Generation

59-880. Measurements of Hydraulic Turbine Windage and Friction Losses. *R. L. Krahn*, U.S. Army Corps of Engineers.

59-819. Performance of Large Waterwheel Generator Pivoted Pad Thrust Bearing Determined by Tests under Normal Operating Conditions. *R. A. Baudry, E. C. Kuhn, G. D. Cooper*, Westinghouse Electric Corp.

59-881. Automatic Controls of Hydroelectric Stations of the B. C. Electric Company, Ltd. *S. R. Hayden, E. P. Ehmayer, H. A. Baumann, R. S. Moulds*, B. C. Engineering Co., Ltd.

CP59-933. Electric Features of the Niagara Power Project. *J. Saloma*, Charles T. Main, Inc. Presented by L. M. Berry.

Relays

CP59-796. System Swing Detector Relay. *J. N. Haroian*, Idaho Power Co.

59-775. An Automatic Trip-and-Carrier Test for Phase Comparison Carrier Current Relays. *R. W. Hirtler*, The City of Los Angeles Dept. of Water and Power.

59-797. Special Circuits for Ground Relay Current Polarization from Autotransformers Having Delta Tertiary. *P. A. Oakes*, Idaho Power Co.

CP59-798. Optimum System and Motor Protection through Proper System Grounding and Relaying. *R. W. Swarthout*, General Electric Co.; *R. C. Dickson*, Phelps Dodge Copper Refining Corp.

Rotating Machinery

59-684. Electronic Surge Testing of Universal Armatures with Null Detection. *H. R. Weed*, Ohio State University.

CP59-803. Amplitude Build-Up during Acceleration of Oscillatory Systems Possessing Several Degrees of Freedom. *O. I. Elgerd*, University of Florida.

Radiation Effects Symposium I: Economic and Engineering Aspects of Nuclear Power

CP59-1020. The Economic Utilization of Nuclear Power. *H. Vann*, Atomic Energy Commission.

CP59-983. Some Control and Auxiliary Power Aspects of Nuclear Power Plants. *A. R. Jones*, Westinghouse Electric Corp.

CP.* Radiation Effects Problems in Electronic Design. *D. M. Newell, P. S. Miglicco*, Convair.

Industrial and Commerical Power Systems

CP59-815. Electrical Distribution in British Industrial Plants. *H. Clay*, McLellan and Partners.

CP59-816. Gas Turbine Drive for Industrial Power Generation. *Z. S. Stys*, Brown Boveri Corp.

CP59-977. A New Approach to Commercial Building Power Distribution. *C. F. Hanson*, Pacific Telephone and Telegraph Co.

Optimum Nonlinear Control

CP59-836. Switching Criteria for Certain Contactor Servomechanisms with Arbitrary Inputs. *C. A. Anderson*, Maxwell Air Force Base.

CP59-837. Modified Optimum Nonlinear Control. *T. Mitsumaki*, Hitachi Central Research Lab.

59-838. A Practical Standard Transistorized Optimum Response Controller. *K. Chen*, Westinghouse Electric Corp.; *D. R. Little*, Curtiss-Wright Corp.

CP59-840. Dual Mode Relay Servos. *R. N. Buland*, Aeronutronic Systems Inc.; *N. Furumoto*, University of California.

Telemetering System Considerations

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Electric Heating in Schools, Churches, etc.

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CP59-927. Electric Floor Heating by Steel Grid Mesh System. *G. E. Hutchcroft, H. P. Gluckman*, Los Angeles Dept. of Water and Power.

Power Generation

59-877. Power Plant Control Board Locations and Operations. *E. G. Norell*, Sargent and Lundy.

CP59-878. Minimum Recommended Protection for Unit-Connected Steam Stations. AIEE Working Group on Steam Station Protection of the Power Generation Committee, D. M. Sauter, chairman.

CP59-866. Automatic Power Control of a Seed and Blanket Power Reactor Plant through Use of a Cyclic Device and Contactor Control System. *R. Saucedo*, Westinghouse Bettis Atomic Power Dept.; *D. J. Ford*, University of Pittsburgh.

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CP.* Effects of Irradiation in Materials. *D. K. Holmes*, Oak Ridge National Laboratory.

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Control Systems

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59-828. Analysis of Nonlinear Sampled-Data Control Systems, Part I. *E. Kinnen, J. Tou*, Purdue University.

59-829. Analysis of Nonlinear Sampled-Data Control Systems, Part II. *E. Kinnen, J. Tou*, Purdue University.

59-830. Design of Continuous Linear Control Systems for Minimum Probabilistic Error. *J. Zaborsky*, Washington University; *J. W. Diesel*, McDonnell Aircraft Corp.

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Relays and Transmission and Distribution

58-1229. Distribution Protection as Used on the Portland General Electric Co. System, Portland, Ore. *M. A. Bostwick*, Portland General Electric Co.

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59-874. A New High-Capacity Microwave Relay System. *C. G. Arnold, V. E. Isaac, H. R. Mathwich, R. F. Privett, L. E. Thompson*, Radio Corporation of America.

59-889. Microwave Systems on the Pacific Great Eastern Railway. *R. N. Doble*, Pacific Great Eastern Railway, Co.; *J. E. Raftis*, Canadian Motorola Electronics, Ltd.

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CP.* Some Technical Aspects of Video Tape Recording, *J. L. Middlebrooks*, Radio KING, Seattle, Wash.

CP59-1014. Advancement in Mobile Communications. *J. S. Smith*, General Electric Co.

59-920. Global Public Telephone Service—1958. *D. D. Donald, T. A. Chandler*, American Telephone and Telegraph Co. (Re-presented for discussion only.)

59-944. A Transistorized Pulse-Code Repeater. *G. R. Partridge*, Raytheon Mfg. Co.

CP59-768. Spectral Folding in a Single-Tone FM Signal. *J. J. Bussgang*, Radio Corp. of America; *A. H. Nuttal*, Massachusetts Institute of Technology.

59-925. An Approach to the Study of Automatic Target Tracking. *L. Pode*, Sherman Oaks, Calif.

Space Vehicle Instrumentation

CP.* Analysis of Thermal Instrumentation Capability for Hypervelocity Re-entry Vehicles. *L. Foster*, General Electric Co.

CP.* Motion Parameter Measurements for a Re-entry Vehicle Following a Ballistic Trajectory. *J. Picard*, General Electric Co.

CP.* Integrated Instrumentation in Man-Vehicle Systems. *C. Gibson*, Douglas Aircraft Co., Inc.

Transmission and Distribution

59-808. Electromagnetic Unbalance of Untransposed Transmission Lines—III Double Circuit Lines. *E. T. B. Gross*, Illinois Institute of Technology; *J. H. Drinnan*, British Columbia Engineering Co., Ltd.; *E. Jochum*, Allis-Chalmers Mfg. Co.

59-807. Corona and Conductor Work Function. *H. S. Dixon*, Berkeley Laboratory.

59-767. Development of a Square Law Radio Noise Meter—II. *F. J. Trebby*, Kaiser Aluminum and Chemical Corp.

59-896. EHV Single and Twin Bundle Conductors — Influence of Conductor Diameter and Strand Diameter on Radio Influence Voltage and Corona Initiation Voltage. *L. N. Stone*, Oregon State College.

59-814. Radio Interference Attenuation on Energized High-Voltage Transmission Lines, Measurement, and Application. *L. N. Stone*, Oregon State College; *R. S. Gens, E. H. Gehrig*, Bonnerville Power Administration.

Mobile Transformers and Substations

CP59-842. Field Experience with 15,000-Kva Highway Mobile Transformers. *R. E. Brown, J. W. Pettinos*, City Public Service Board of San Antonio, Texas.

CP59-843. Application of Large Mobile Transformers on Pacific Gas & Electric Company System. *J. L. Buckley*, Pacific Gas & Electric Co.

CP59-932. Design of a 40-Mva Mobile Transformer/Autotransformer. *J. E. Hall*, General Electric Co.

CP59-974. Railway- and Highway-Type Mobile Transformers on BPA System. *L. I. Gradasoff*, Bonneville Power Administration.

Magnetic Amplifiers

59-788. Theory of Ferroresonance. *J. T. Salihi*, Lenkurt Electric Co., Inc.

CP59-789. Graphical Evaluation of Magnetic Amplifier Performance Based on Constant-Voltage Reset Test. *D. Nitzan*, University of California.

59-635. Shunt-Coupled Magnetic Amplifier Circuits. *R. M. Hubbard*, Boeing Airplane Co. (Re-presented for discussion only.)

59-790. Magnetic Amplifier Circuits — A Classification of Half-Wave and Full-Wave Nonreversible and Reversible Self-Saturating Circuits. *D. L. McMurtrie*, Raytheon Manufacturing Co. (Re-presented for discussion only.)

59-791. All-Transistor Magnetic Core Memories. *B. T. Goda, W. R. Johnston, S. Markowitz, M. Rosenberg, R. Stuart-Williams*, Telemeter Magnetics, Inc. (Re-presented for discussion only.)

59-776. The Winding Capacitances in Magnetic Amplifiers. *I. Johansen*, Massachusetts Institute of Technology.

Thermoelectric Generators

59-867. An Elementary Design Discussion of Thermoelectric Generation. *E. W. Bollmeier*, Minnesota Mining and Manufacturing Co.

CP59-937. Minimizing the Weight of Thermoelectric Generators in Space Applications. *D. L. Kerr, R. L. Gessner*, General Electric Co.

59-847. Solar-Powered Thermoelectric Generator Design Considerations. *N. F. Schuh*, Westinghouse Electric Corp.; *R. J. Tallent*, Boeing Airplane Co.

CP59-887. Utilization of Thermoelectric Effects for Power Generation. *W. W. Happ, S. R. Hawkins*, Lockheed Aircraft Corp.

Communication Theory

CP.* Figure of Merit for Information Networks. *L. S. Schwartz*, New York University.

59-809. An Experimental Study of Detection in Nonstationary Noise. *T. R. Williams, J. B. Thomas*, Princeton University.

CP59-1008. An Error-Correcting Code for Quaternary Data Transmission. *E. H. Scherer*, Westinghouse Electric Corp.

Power Sources

CP59-910. Conception Design of a Thermionic Space Power Plant. *F. N. Huffman*, The Martin Co.

CP59-911. Nuclear Thermoelectric Power Supply. *R. J. Harvey*, The Martin Co.

CP59-934. Minimum-Weight Thermoelectric Generators Applied to Air-Breathing Propulsion Systems. *P. C. Holden, R. E. Klokow*, Westinghouse Electric Corp.

CP59-982. Generation of Electric Power in

Space Vehicles by Means of a Cryogenic Fuel Powered Engine. *H. Howard, R. Laughlin, N. Morgan,* Vickers, Inc.

Reliability

59-888. Reliability Analysis for Aircraft Generators. *J. T. Duane, L. J. Yeager,* General Electric Co.

59-912. Functional Cycling To Assure Reliability of Aircraft Control Equipment. *R. E. Hulsey, L. L. Kessler,* Westinghouse Electric Corp.

CP59-871. A Method of Comparative Reliability Prediction for Developmental Design Selection. *V. L. Grose,* Boeing Airplane Co.

59-565. The Effect of Variable High-Altitude Humidity on the Wear of Non-dusting Brushes. *L. E. Moberly, J. L. Johnson,* Westinghouse Electric Corp.

Rapid Transit

CP59-856. Automania Gives Way to Rapid Transit in the Bay Area. *J. C. Becker,* San Francisco Bay Area Rapid Transit District.

CP59-782. Planning for Public Transportation. *M. O. Anderberg,* Seattle Transit System.

CP59-945. A Study of Mass Transportation Needs in Metropolitan Los Angeles. *C. T. Abbott,* Coverdale & Colpitts.

Pulp and Paper Industry

CP59-964. Practical Analysis of Regulating Systems for the Paper Industry. *R. J. Starrett,* Reliance Electric and Engineering Co.

CP59-853. Cable Applications in Paper Mills. *E. E. McIlveen,* The Okonite Co.

CP59-1017. Application of Computer Control in Pulp and Paper Manufacture. *T. M. Stout,* Thompson-Ramo-Woolridge Products Co.

59-813. Transistor Amplistat Regulated Sectional Drive at Southland Paper Mills. *A. E. Vickery,* Southland Paper Mills; *G. E. Shaad,* General Electric Co.

Transmission and Distribution

CP59-859. Effect of Twin Conductor Arrangement on Transmission Line Constants. *F. Taher,* University of Cairo.

59-897. EHV Single- and Twin-Bundle Conductors — Electrical Characteristics and Conductor Selection. *E. Hazan,* Kaiser Aluminum and Chemical Corp.

CP59-898. Short-Time Annealing Characteristics of Electrical Conductors Part I: Methodology. *L. F. Roehmann,* Kaiser Aluminum and Chemical Corp.

59-899. Laboratory and Field Evaluation of Connectors and other Accessories for Aluminum Conductors in Severe Marine Environments. *W. J. Sanders,* Kaiser Aluminum and Chemical Corp.

58-449. High-Strength Aluminum Alloy Conductors. *E. W. Greenfield,* Kaiser Aluminum and Chemical Corp. (Re-presented for discussion only.)

Substations

59-781. Modular Design for Aluminum Substation Structures. *G. W. Swanson, P. A. McCleer,* Consumers Power Co.

CP.* Aluminum Alloy Substation Structures. *J. E. Williams,* Aluminum Company of America; *A. D. Sangdahl,* H. K. Porter Co., Inc.

CP.* Recent Developments in Aluminum Substation Structures. *R. H. Vaterlaus,* Kaiser Aluminum & Chemical Corp.

59-189. Rationalization of Electrical Clearances for Application at EHV's 230 Kv to 460/500 Kv. *P. L. Bellaschi,* Portland, Ore. (Re-presented for discussion only.)

Magnetic Amplifiers

59-765. Transistor–Magnetic Control Circuits for Aircraft Electric Systems. *A. W. Pratt,* Jack & Heintz, Inc.

CP59-784. Magnetic Amplifier Regulated Rectifiers. *A. S. FitzGerald,* Mill Valley, Calif.

59-785. Capacitively Coupled Magnetic Amplifiers. *H. W. Collins,* Westinghouse Electric Corp. (Re-presented for discussion only.)

59-786. A More Stable 3-Phase Transistor-Core Power Inverter. *W. E. Jewett, P. L. Schmidt,* Bell Telephone Labs., Inc. (Re-presented for discussion only.)

59-668. Analog Division Circuit. *W. McMurray,* General Electric Co. (Re-presented for discussion only.)

CP59-787. Use of a Series Saturable Reactor As a Fluorescent Lamp Dimming Ballast. *P. E. Massie,* Day-Ray Products, Inc.

Transformers

59-783. An Economic Analysis of Distribution Transformer Application. *C. F. Mitchell,* Commonwealth Edison Co.; *J. O. Sweeny, J. L. Cantwell,* General Electric Co.

CP59-955. Universal Connectors for Distribution Transformers. *M. Brenner,* Penn-Union Electric Corp.

59-818. Vaporization Cooling for Power Transformers. *P. Narbut, A. J. Maslin,* Westinghouse Electric Corp.; *C. Wasserman,* Baltimore Gas and Electric Co.

59-854. Fault Pressure and Gas Detector Relays. *H. A. Fohrhaltz,* General Electric Co.

57-1146. Standard Basic Impulse Insulation Levels. Report by the AIEE Standards Co-ordinating Committee No. 8, J. H. Foote, chairman. (Re-presented for discussion only.)

Plastic Insulated Telephone Wire and Cable

59-792. Manufacture of Composite Cable Sheath for Telephone Exchange Cable. *D. A. Hughes,* Western Electric Co.

59-777. The Design and Manufacture of Burial Wire. *J. L. Robb, W. L. Roberts,* Superior Cable Corp.

CP59-793. Design of Polyethylene Insulated Multipair Telephone Cable. *A. S. Windeler,* Bell Telephone Labs., Inc.

59-778. Transmission Properties of Polyethylene Insulated Telephone Cables at Voice and Carrier Frequencies. *G. S. Eager, Jr., L. Jachimowicz, I. Kolodny, D. E. Robinson,* General Cable Corp.

Design Problems

CP.* The Materials Problem in Secondary Nuclear Power, *W. L. R. Rice,* Wright Air Development Center, USAF.

59-873. Nuclear Radiation and Electronic Equipment. *J. R. Crittenden,* General Electric Co.

59-915. Temperature Prediction in Thermal-Lag Equipment. *P. B. Richards,* Thompson Ramo Wooldridge, Inc.

59-879. Characteristics and Measurement of Ripple in Aircraft Electric Power Systems. *O. Markowitz,* U. S. Naval Air Development Center.

Power Sources

CP59-914. Electrostatic Power Generation for Space Propulsion. *O. P. Breaux,* United States Air Force.

CP59-855. Electrochemical Auxiliary Power Sources for Missiles and Space Flight. *M. Eisenberg,* Lockheed Aircraft Corp.

CP59-915. A Simple Variable-Speed Independent-Frequency Generator. *A. K. Wickson,* Canadian Westinghouse Co., Ltd.

CP59-861. Space Electric Power Transmission. *G. W. Bills,* North American Aviation, Inc.

Land Transportation

59-779. A High-Capacity Maintenance-Free Generating System for Motor Coaches. *R. L. Larson,* General Motors Corp.

59-492. Multiple-Unit Operation of Diesel and Electric Locomotives on the Milwaukee Road. *L. Wylie,* Seattle, Wash.

CP59-799. Semiconductor Rectifiers for Traction Power on Electric Railways. *V. E. Staff,* DeLeuw Cather & Co.; *S. B. Lent,* Metropolitan Transit Authority.

Transmission and Distribution

59-900. Sag-Tension Computations and Field Measurements of Bonneville Power Administration. *P. F. Winkelman,* Bonneville Power Administration.

59-868. Design of Overhead Lines with 5005 Alloy Aluminum Cables. *H. W. Adams,* Reynolds Metals Co.

CP59-901. Fatigue Characteristics of EC and 5005 Alloy Aluminum Wire. *C. E. Burley,* Reynolds Metals Co.

59-801. Factors Affecting Vibratory Stresses in Cables Near the Point of Support. *R. F. Steidel, Jr.,* University of California.

59-178. Improved Systems for Recording Conductor Vibrations. *C. B. Rawlins, J. R. Harvey,* Aluminum Co. of America. (Re-presented for discussion only.)

Transformers

59-281. Accelerated Aging Characteristics of Formex and Paper Insulated Wires in Transformer Oil. *M. F. Beavers, H. H. Brustle, J. H. Carpenter, W. J. Degnan,* General Electric Co.

CP59-952. A New Insulation System. *M. F. Beavers, E. L. Raab, J. C. Leslie,* General Electric Co.

CP59-990. Factors Affecting the Aging Characteristics of Various Wire Coating Materials in Transformer Oil. *G. F. Lipsey, P. W. Juneau, Jr.,* General Electric Co.

SP-76. Proposed Guide for Maintenance of Transformer Askarel. Report by Insulating Fluids Subcommittee of AIEE Transformer Committee, C. P. Xenis, chairman.

58-1150. The Relationship Between Operating Voltage and the Standard Dielectric Tests for Power and Distribution Transformers. Dielectric Tests Subcommittee of AIEE Transformers Committee Working Group, H. H. Wagner, chairman. (Re-presented for discussion only.)

Wire Communications

59-774. Synthesis of Cable Simulation Networks. *R. W. DeMonte,* Bell Telephone Labs., Inc.

59-794. A new Transistorized Negative Impedance Telephone Repeater. *R. P. Dimmer, E. L. Roback,* General Telephone Labs.

CP59-855. Design Features of the 45-C2 Carrier Telephone System. *V. Babin,* Lenkurt Electric Co.

Argonne National Laboratory

EXPERIMENTAL Boiling Water Reactor (EBWR) at Argonne National Laboratory, Lemont, Ill., *(above, left)* is one of the places which will be visited during the AIEE Fall General Meeting. EBWR provides most of the power used daily at the Laboratory's 3,700-acre site. This is a direct cycle boiling, 20,000-kw (heat) reactor which provides the energy for generating 5,000 kw of electricity. Argonne is operated by the University of Chicago for the U. S. Atomic Energy Commission. Commonwealth Edison Fisk Station *(above, right)* is the subject of another inspection trip during the Fall General Meeting. A new 325-mw generating unit, as well as older units, will be viewed.

Fall General Meeting Scheduled for October 11-16 in Chicago, Ill.

ARRANGEMENTS for the Fall General Meeting of the AIEE, to be held at the Morrison Hotel in Chicago, Ill., October 11-16, 1959, are being finalized. The full facilities of the Morrison Hotel will be utilized for technical sessions, social functions, and ladies activities. In addition, some of the technical sessions will be held in the Sherman Hotel in conjunction with the National Electronics Conference (NEC).

Provision has been made for reciprocal registration between the AIEE and NEC, whereby a registrant for the AIEE meeting may also register for NEC upon request. NEC registrants may register for the AIEE meeting upon payment of difference in registration fees. The NEC will headquarter in the Sherman Hotel and will feature an extensive exhibit of manufacturer's equipment.

The tentative technical program shows a total of 63 technical sessions. There also will be one general session on Monday afternoon. The technical sessions will cover a wide variety of subjects. Seven sessions will be run concurrently each morning and afternoon, but will be scheduled so that meetings on subjects in the same general area of interest do not occur at the same time. Six nucleonics sessions should provide a very interesting coverage of this timely subject. Also included in the program are papers on basic sciences, communications, rotating machinery, computing devices, transportation, transformers, substations, and other phases of the electrical industry. There will be technical sessions at 9:00 a.m. and 2:00 p.m. each day, Monday through Friday, except Monday afternoon when the general session will feature a well-known guest speaker.

The inspection trips scheduled for the meeting are intended to be both informative as well as interesting and cover such subjects as data logging equipment, economic dispatch equipment, Argonne and Dresden reactors, and equipment for automation.

There are seven major trips planned, with four shorter "walk-over trips." There will be no charge for the "walk-over trips." The major trips will consist of visits to Argonne Laboratories, featuring the Experimental Boiling Water Reactor and an auditorium session on the new particle accelerator; Commonwealth Edison's Fisk Street Station, inspecting a new 325-mw generating unit as well as older units, also including an auditorium session on Dresden Nuclear Power Station; Panellit Products Company, inspection of panelboards, annunciators, etc., with a demonstration of data logging equipment; Hubbard & Company High-Voltage Laboratory, demonstration of high-voltage testing of electrical switching equipment; Automatic Electric Company, inspection of telephone devices as well as special equipment for automation; Chicago Harbor Authority, presentation of plans for future development as well as inspection of present terminal facilities; Electromotive Division of General Motors Company, inspection of plant facilities featuring diesel-generating units for emergency and peaking service.

The "walk-over trips" will be held at Commonwealth Company, demonstrating the very newest equipment for automatic dispatching and economic loading; *Sun-Times* building, featuring one of Chicago's major newspapers going to press; Northwestern Railway Depot, inspection of new bi-level *400* railroad cars and possibly the new push-pull suburban trains; Underwriters' Laboratories, showing various device testing equipment.

A program designed for the ladies enjoyment will be in full swing throughout the meeting. The ladies hospitality headquarters will be located in Room 522 at the Morrison Hotel. On Monday, there will be a coffee hour in the morning and a dessert card party in the afternoon. Tuesday morning, a sight-seeing tour of the city's South Side is planned with a luncheon at the South Shore Country Club. After lunch Miss Sulie Harand will present her entertaining version of a musical, "The Flower Drum Song." On Wednesday, there will be a brunch at the famous Carousel Room atop the Morrison Hotel, and Thursday's schedule includes a luncheon and tour at the Art Institute.

In addition, there will be the Sunday afternoon welcoming tea and the Fall Frolic Show on Wednesday evening.

There will be a ladies registration fee of $2 and a nominal charge for tickets to the ladies special activities.

Notice to Technical Committee Chairmen

The 21st Forum of Technical Committee Chairmen, Vice-Chairmen, and Technical Operations Department (TOD) District Representatives will be held in the Morrison Hotel in Chicago, Ill., in connection with the AIEE Fall General Meeting on Thursday, October 15, 1959, at 7:30 p.m. The room location will appear in the final program.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

Awards To Be Presented at AIEE Fall General Meeting

The Recognition Awards Committee of the Institute has announced the following awards to be made at the general session of the Fall General Meeting, in Chicago, Ill., on October 12, 1959:

Medal in Electrical Engineering Education—Dr. G. S. Brown (F '50), dean of engineering, Massachusetts Institute of Technology (MIT), Cambridge, Mass.

First Award of the William Martin Habirshaw Award—W. A. Del Mar (F '20), consulting engineer, Phelps Dodge Copper Products Corporation, Yonkers, N. Y.

First Award of the Morris E. Leeds Award—Dr. H. B. Brooks (F '31), Washington, D.C.

G. S. Brown

Dr. Brown was born August 30, 1907, in Drummoyne, New South Wales, Australia. In 1925, he received the mechanical engineering and electrical engineering diplomas from the Melbourne Technical School. He went to MIT in 1929, where he received the B.S. degree in 1931, the M.S. degree in 1934, and the D.S. degree in 1938, all in the department of electrical engineering. He was appointed research assistant in electrical engineering at MIT in 1931, instructor in 1932, assistant professor in 1939, associate professor in 1941, and professor in 1946. In 1952, he was appointed head of the department of electrical engineering and 1959, Dean of Engineering. He was elected chairman of the faculty for 1951-52. He served as an exchange professor at Purdue University in 1935 and received the honorary degree of Eng.D. from Purdue in 1958. In April 1956, Dr. Brown was chosen to be Visiting Mackay Professor of Electrical Engineering at the University of California at Berkeley. From April through May 1958, he was the J. I. Carroll Memorial Fellow at the University of Sydney in Australia.

Dr. Brown established the Servomechanisms Laboratory at MIT in 1941, and served as its director until 1952. He and his laboratory colleagues undertook an extensive program of research and education for the armed services. He was the first chairman of the AIEE Feedback Control Systems Committee. During the wartime period, Dr. Brown also served as consultant to the Fire Control Department of the Sperry Gyroscope Company, and from 1942 to 1944 he was War Department consultant to the Fire Control Design Section of the Frankford Arsenal.

Dr. Brown received the President's Certificate of Merit and the Naval Ordnance Development Award in 1948. He received the George Westinghouse Award of the American Society for Engineering Education (ASEE) in 1952.

In the last few years, Dr. Brown has become widely known for his pioneer work in evolving a new synthesis of science and technology for training future electrical engineers.

Dr. Brown is a fellow of the American Academy of Arts and Sciences and the Institute of Radio Engineers (IRE). He is director-at-large of the IRE, 1958-60. He is a member of the ASEE, Sigma Xi, Tau Beta Pi, and Eta Kappa Nu. He is a member of the advisory council of the department of electrical engineering of Princeton University; of the board of overseers of the Thayer School of Dartmouth College.

Dr. Brown is the author of numerous technical papers and articles on engineering education. He is co-author with the late Donald P. Campbell of the book "Principles of Servomechanisms."

W. A. Del Mar

Mr. Del Mar has been an active worker in AIEE since he joined in 1906, having served on the Board of Managers, 1917-22, and as the first vice-president of the New York District, 1921-22. He has been chairman or active member of numerous committees of the Institute and other engineering organizations. For example, he holds a record for membership in the Standards Committee having been a regular member for 12 years and a liaison member for 32 years. He also holds a record for membership in the Insulation Conference of the National Research Council, having been one of the founders in 1920, and serving as vice-chairman for 17 years and acting-chairman for 2 years. He was also one of the founding members of the Insulated Power Cable Engineers Association of which he has been a member since 1927 and president in 1938-39.

Mr. Del Mar was born in San Francisco, Calif., December 15, 1880. He received his technical education at the college now known as the City and Guilds College, which is an affiliate both of the Imperial College of Science and Technology and of the University of London. There he studied electrical engineering under Ayrton and Mather, graduating in 1900 with the degree of associate of the City and Guilds Institute. In 1952, his alma mater gave him the honorary degree of fellow of the City and Guilds Institute, the citation being ". . . for having contributed to the advancement of the industry in which he has been engaged either in the course of professional practice or in the form of original research."

Mr. Del Mar's early experience was with transmission and distribution for electric railroads. He was technical assistant in the electric traction department of the New York Central Railroad during the electrification of the New York area and later, assistant electrical engineer to the Interborough Rapid Transit Company of New York City, in which capacity he had the task of co-ordinating into one system the three separate transmission and distribution systems of the elevated, surface, and subway systems.

The organization which was later to become the Habirshaw Cable and Wire Division of the Phelps Dodge Copper Products Corporation, invited Mr. Del Mar to become its chief engineer in 1917, a post he held until 1952 when he retired on a part-time basis as consulting engineer.

Dr. Brooks was born January 25, 1869, in New Bremen, Ohio. At age 17, he was apprenticed to the Piqua (Ohio) Edison Electric Illuminating Company, whose plant was the fifth Edison "central station" in this country. In his second year, the company sent him to the Edison Machine Works at Schenectady, N. Y., where he was soon placed on the payroll as a member of the test room staff. He was loaned for several weeks to the parent company, the Edison Electric Light Company of New York City, where his work included operating Edison isolated plants and "trouble shooting." In the following autumn, at age 18, he was called back to Piqua and promoted from apprentice to superintendent and electrician. After 11 years in this position, he resigned to study electrical engineering at Ohio State University. At the beginning of his third year he was appointed student assistant in physics. After 2 years, he left this position to become student assistant in electrical engineering. He graduated in 1903, and at once entered the recently established U. S. National Bureau of Standards in Washington, D.C. This proved to be the field for which all his previous years had been the preparation. In 1906, he became the first chief of the Electrical Instrument Section.

H. B. Brooks

In 1911, Dr. Brooks was loaned to the Bureau of Foreign and Domestic Commerce. As a commercial agent of this Bureau, he visited 31 leading foreign makers of electrical instruments and (integrating) meters. The results of this study were published in 1913 by the Government Printing Office as Special Agents Series No. 66, "Electrical Instruments and Meters in Europe."

As a member of AIEE Committee on Instruments and Measurements, he felt very strongly that there should be American standards for electrical measuring instruments. After 5 years of advocating the establishment of such standards, he was allowed to prepare a tentative draft for comment and criticism. This work culminated in the establishment of American Standard C39.1 for Electrical Measuring Instruments.

His best-known inventions are: the deflection potentiometer; a variable self- and mutual inductor (the so-called "inductometer"); and the standard-cell comparator. He continues to work in his basement shop and laboratory. In retirement, he has published two papers, "Electrical Indicating Instruments used in Early Edison Central Stations," and "Inductive Efficiency of Reactive Coils." He has another investigation in progress.

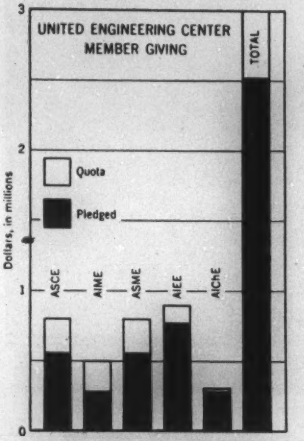
Dr. Brooks received his Ph.D. from Johns Hopkins University in 1926. He was awarded the Lamme Medal, Ohio State University, in 1948.

Activities of Subcommittee on Component Specifications

During the past 3 years, a Subcommittee of the AIEE Feedback Control Systems Committee attempted to determine, and in some cases to spell out, the necessary specifications required for components used in control systems. This Component Specifications Subcommittee has co-ordinated its activities with many groups interested in the area of components.

At the 1959 Winter General Meeting of the Institute, an entire afternoon session was devoted to the subject of component specifications from the control systems or dynamic response point of view. Wherever possible, the Subcommittee has not desired to write new specifications, but they have been interested in inserting dynamic response criteria into existing specifications or in working with groups preparing new specifications. Where no specifications are in existence, then the Subcommittee has initiated such action. As an example, in the area of the hydraulic transfer valve, Dr. John Gibson has undertaken the actual writing of such a specification.

The next step undertaken by the Subcommittee was to plan a Control Systems Components Conference. This Conference will be held jointly with the National Automatic Controls Conference, November 5-6, 1959, at the Sheraton Hotel in Dallas, Texas. The Conference will be a joint effort with the Institute of Radio Engineers, Society of Automotive Engineers, Instrument Society of America, and American Society of Mechanical Engineers.



THE BAR GRAPH shows the status of member giving as of July 31, 1959. All contributions to the United Engineering Center Building Fund are tax deductible.

Student Branches Present Building Fund Contributions

Seven Student Branches in District No. 6 of the Institute have made contributions as follows to the United Engineering Center Building Fund:

Branch	Contribution
University of Denver	$25
South Dakota State College	10
South Dakota School of Mines	25
Iowa State College	25
University of Wyoming	20
Colorado State University	30
University of Nebraska	25
TOTAL	$160

Previously, several individual Branches had made contributions to the Building Fund, but this is the first District effort along these lines.

Program for Engineering Management Conference

A tentative program of the 7th Annual Engineering Management Conference, to be held September 17-18, 1959, at the Statler Hilton Hotel in Los Angeles, Calif., has been announced. Representatives of seven engineering societies will participate in the program, which will cover such topics as development of engineering managers, new concepts of engineering controls, and engineering planning.

Co-sponsored by AIEE and the American Society of Mechanical Engineers (ASME), the Conference also has the support of the American Institute of Mining, Metallurgical, and Petroleum Engineers; the American Institute of Industrial Engineers, Inc.; the American Society of Civil Engineers; the American Institute of Chemical Engineers, and the Los Angeles Section of the Institute of Radio Engineers.

The tentative program follows:

Thursday, September 17

9:30 a.m. Session I Development of Engineering Managers

Chairman: To be announced

Vice-Chairman: H. J. Kraig, Ernst & Ernst

Philosophy of Engineering Management. *J. L. Young*, U.S. Steel Corporation

Developing Managerial Abilities. *F. F. Bradshaw*, Richardson, Henry & Bellows

2:30 p.m. Session II Development of Engineering Managers

Chairman: Dr. Bruce Old, Arthur D. Little, Inc.

Vice-Chairman: W. M. Pollit, Hughes Aircraft Company

Management of Engineering and Scientific Programs. *Louis Dunn*, Space Technology Laboratory, Inc.

Delevopment of Engineering Managers in an Industrial Organization. *J. L. Atwood*, North American Aviation, Inc.

Development of Engineering Managers in a Governmental Organization. *B. S. Grant*, Department of Water & Power, City of Los Angeles, Calif.

6:00 p.m. Social Hour

7:00 p.m. Banquet

Chairman: H. A. Bogle, E. I. du Pont de Nemours & Co. (Inc.)

Banquet Address: "Development of Engineering Statesmanship," by Honorable G. D. Clyde, Governor, State of Utah.

Friday, September 18

9:30 a.m. Session III New Concepts of Engineering Controls

Chairman: P. F. Lueth, Economics & Planning Union Oil Center

Vice-Chairman: R. A. Skinner, Metropolitan Water District of Southern Calif.

Control of the Engineering Function. *H. H. Goode*, University of Michigan, and Bendix Aviation Corp.

Development of Integrated Engineering Controls. *J. S. Sayer*, E. I. du Pont de Nemours & Co., (Inc.)

Development of Integrated Engineering Controls—Case History. *N. J. Ream*, Lockheed Aircraft Corp.

12:15 p.m. Luncheon

Chairman: H. O. Fuchs, Metal Improvement Co.

Luncheon Address: "Some Problems that Face the Engineering Profession in the Management Field." G. B. Warren, General Electric Company; president, ASME

2:30 p.m. Session IV Engineering Planning

Chairman: C. S. Purnell, Westinghouse Electric Company

Vice-Chairman: K. E. Hegardt, Pacific Telephone & Telegraph Company

Decision Making in Engineering. *W. L. Nichols*, Arthur D. Little, Inc.

Engineering Programs for New Frontiers. *G. P. Sutton*, Advanced Research Projects Agency, Department of Defense

For advance registration and information, write to: 1959 Engineering Management Conference, P.O. Box 331, Reseda, Calif.

College Freshmen Reply to ECPD Survey

The question "What was the principal motivating influence in your selection of engineering as a career?" was asked of college freshmen by the Guidance Committee of the Engineers' Council for Professional Development (ECPD). Colleges throughout the United States were divided into eight regions and the replies varied very little from one region to another.

Of the 9,967 who replied, 25.7% stated that "family" was the main motivating influence, while "teacher" and "friend" were nearly equal with 12.1% and 10% respectively. "School counselors" were credited with but 5.5% and "availability of a scholarship" with 2.0%. The 44.7% who answered "other" were influenced by military or job experience, preference for mathematics and science, contacts with engineers in the field, ability, etc.

It is of interest that those of the 2,450 students replying who indicated their courses, 737 were studying electrical engineering, 730 were taking mechanical engineering, with 335 taking chemical, 322 civil, 234 aeronautical, and 92 industrial engineering.

Because of the predominating influence of the family in this survey, the Committee concludes that engineering's importance should be brought before PTA groups and service clubs, and should receive publicity during activities such as Engineers' Week.

Editor Emeritus of the ASME Dies

George A. Stetson, editor emeritus, American Society of Mechanical Engineers (ASME), including *Mechanical Engineering* magazine, died recently in Stamford, Conn. He was 70 years of age.

Mr. Stetson was credited by his colleagues with raising *Mechanical Engineering* to a prominent position among technical journals in the English language, and with introducing over a period of years a number of editorial innovations that have since been widely adopted.

Educated at Yale University, Mr. Stetson received the Ph.B. degree in 1910 and a graduate degree in mechanical engineering 5 years later. He taught at Yale from 1913 until 1923 as an assistant professor of mechanical engineering and at New York University from 1924 to 1928 as associate professor of heat power engineering.

In 1928, Mr. Stetson joined ASME as assistant editor and 2 years later became editor of all ASME publications including *Mechanical Engineering*, *Transactions*, *Journal of Applied Mechanics*, and *Applied Mechanics Review*. He became editor emeritus in 1956.

In 1954, the Yale Engineering Association presented a certificate of award to Mr. Stetson for "his outstanding service to the Yale School of Engineering." Previously, he had received honorary degrees of doctor of science from Stevens Institute of Technology and doctor of engineering from Rose Polytechnic Institute.

George A. Stetson

A fellow of ASME, he was also a member of the American Association for the Advancement of Science, the American Society for Engineering Education, Sigma Xi, Iota Alpha Pi, Tau Sigma, the Newcomen Society, Engineer's Club of New York, and was a past president of the Yale Engineering Society.

Nonlinear Magnetics and Magnetic Amplifiers Conference

The 4th annual Special Technical Conference on Nonlinear Magnetics and Magnetic Amplifiers will be held at the Shoreham Hotel in Washington, D. C., September 23-25, 1959. The Conference is sponsored by the AIEE Committee on Magnetic Amplifiers and the Institute of Radio Engineers (IRE) Professional Group on Industrial Electronics.

Some 25 technical papers will be presented in five sessions. A session on computer magnetics reflects the widening use of nonlinear magnetic devices in computer technology. The versatility of circuits utilizing magnetic and semiconductor devices in combination will be high-lighted in a session devoted to saturating devices and semiconductors. The remaining sessions will concern magnetic amplifier theory, measurements and evaluation, and magnetic amplifier circuits.

Tuesday evening, September 24, will be reserved for informal discussion of Conference topics. Dr. H. F. Storm, of the General Electric Company, will discuss the theory and application of the Parametron, a recent development of the Japanese magnetic amplifier industry. Following Dr. Storm's talk, speakers will lead seminars on computer magnetics, and applications of solid-state devices.

Printed *Proceedings* of the Conference will be available at the time of registration at $7 per copy. Those not attending the conference may order *Proceedings* by mail for distribution after the Conference. Make checks payable to: W. C. Bullock, 5008 Lindsay Rd., Baltimore 29, Md. After the Conference, orders should be placed with the sponsors' headquarters office.

The registration fee will be $5.

Leading manufacturers of magnetic and semiconductor devices will exhibit their products during the Conference.

The tentative technical program follows:

Wednesday, September 23

9:30 a.m. Session I Magnetic Amplifier Theory

Session Chairman: L. A. Finzi, Carnegie Institute of Technology

"Welcoming Address," *David Feldman*, Bell Telephone Laboratories, Inc., chairman of Steering Committee

59-1060 Theory of 3-Phase Bridge Magnetic Amplifier. *H. F. Storm, C. W. Flairty*, General Electric Company.

Time Response Constant and Transfer Function of Magnetic Amplifiers. *E. W. Manteuffel*, General Electric Company.

59-1058 A Mathematical Model for a Magnetic Amplifier Reactor Core. *H. H. Woodson*, Massachusetts Institute of Technology.

59-1046 Analysis of Magnetic Amplifiers Using a Resistive Reactor-Model. *S. Frankenthal*, Massachusetts Institute of Technology.

59-1050 Two-Step Switching of Saturable Reactors. *B. W. Lovell*, Massachusetts Institute of Technology.

2:00 p. m. Session II Circuits and Applications

Session Chairman: H. L. Kellogg, General Electric Company.

59-1053 Elimination of Coupling Problems in Multistage Magnetic Amplifiers. *W. McMurray*, General Electric Company.

A Miniaturized D-C Instrument Transformer. *W. A. Geyger*, U. S. Naval Ordnance Laboratory.

A Sensitive Static Relay Circuit. *J. Rosa*, Westinghouse Electric Corporation.

An Improved Magnetic Modulator for Static Subharmonic Generators. *A. T. Balint*, University of Buffalo.

59-1054 A Magnetic Amplifier Silicon Transistor Power Supply for Missile Application. *B. Mokrytzki, R. A. Stuart*, Westinghouse Electric Corporation.

Thursday, September 24

9:30 a. m. Session III Saturating Devices and Semiconductors

Session Chairman: A. Krausz, Jack & Heintz, Inc.

59-1059 Self-Regulation in Magnetic-Transistor Amplifiers. *C. F. Hardies, R. L. Van Allen*, Magnetics, Inc.

Timing Circuit Using a Saturable Magnetic Core and a Controlled Rectifier. *J. S. Sicko*, General Electric Company.

High-Power Pulse Generation Using Semiconductors and Magnetic Cores. *E. M. Lassiter, P. R. Johannessen, R. H. Spencer*, Massachusetts Institute of Technology.

59-1051 Direct Current Charged Magnetic Pulse Modulator *E. W. Manteuffel, R. E. Cooper*, General Electric Company.

The Magnetic Circuit—The Key to Successful Applications of the Hall Effect. *N. P. Milligan*, Ohio Semiconductors, Inc.

2:00 p. m. Session IV Computer Magnetics

Session Chairman: T. G. Wilson, Duke University.

An Extension of Magnetic Switching Techniques in High-Speed Storage Applications. *R. Stuart-Williams, B. T. Goda,* Telemeter Magnetics, Inc.

A Vacuum Evaporated Random Access Memory. *K. D. Broadbent,* Hughes Research Laboratories.

59-1042 Miniature High-Frequency Magnetic Amplifier for Magnetic Memory Sensing. *G. R. Briggs, K. C. Hu,* RCA Laboratories.

59-1044 Magnetic Amplifier Binary-to-Analog Conversion. *I. Danylchuk, D. Katz,* Bell Telephone Laboratories.

Transfluxor Analog Memory Circuit. *C. L. Boyajian,* General Electric Company.

Friday, September 25

9:30 a. m. Session V Measurements and Evaluation

Session Chairman: E. V. Weir, Magnetics, Inc.

Correlation of Magnetic Amplifier Performance with Core Characteristics. *N. A. Ruggles, P. Real,* Westinghouse Electric Corporation.

A Statistical Determination of Correlation Between Constant Current Flux Reset Testers. *H. B. Airth, G. E. Lynn,* Westinghouse Electric Corporation.

Effects of Environment on the Magnetic Properties of Toroidal Cores. *J. E. Mitch, H. A. Lewis,* Arnold Engineering Company.

59-1061 Some Practical Methods of Obtaining Time of Response. *R. L. Van Allen, P. W. Gaxeri, T. G. Wilson,* Magnetics, Inc.

59-776 The Winding Capacitances in Magnetic Amplifiers. *I. Johansen,* Carnegie Institute of Technology.

AIEE and IRE Sponsor Industrial Electronics Symposium

The 8th Annual Industrial Electronics Symposium, sponsored by the AIEE, the Institute of Radio Engineers (IRE) Professional Group on Industrial Electronics, and the Pittsburgh Sections of AIEE and IRE, is scheduled for September 30-October 1, 1959, at the Mellon Institute, Pittsburgh, Pa.

Co-chairmen for the Conference are: AIEE—Robert Mathias, assistant professor, electrical engineering department, Carnegie Institute of Technology; and IRE—Gary Muffly, assistant division director, Geophysics Development Division, Gulf Research and Development Company. Symposium secretary is D. T. Biel, Fisher Scientific Co., 711 Forbes St., Pittsburgh 19, Pa.

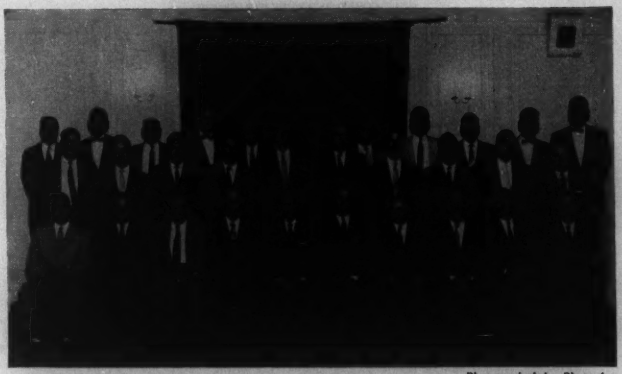
The theme of the Conference will be "Electronics Comes of Age in Industry."

For Information on Machine Tool Conference

The 11th Annual Machine Tool Conference sponsored by the AIEE Machine Tool Subcommittee will be held October 19-21, 1959, at the Sheraton-Cleveland Hotel, Cleveland, Ohio.

For information concerning the Conference, contact: E. J. Loeffler, Warner & Swasey Co., 5701 Carnegie Ave., Cleveland 5, Ohio.

AIEE Philadelphia Section

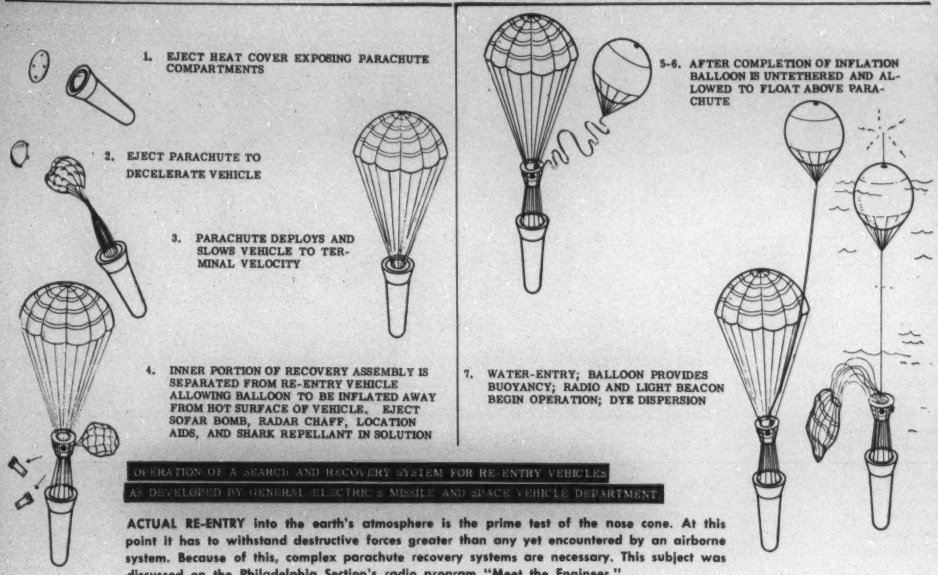


Photographed by Photo-Arts

OFFICERS, executive Committee members, representatives, and committee chairmen of the Philadelphia Section for 1959-60, present at the first Executive Committee Meeting, June 8, 1959, are (*first row, left to right*): J. W. Pobst, manager; F. C. Powell, manager; R. C. R. Schulze, chairman, Atlantic City Division; W. C. Bloomquist, treasurer; R. L. Halberstadt, vice-chairman; R. S. Hewett, chairman; G. B. Schleicher, junior past chairman; R. T. Ferris, manager; T. H. Story, manager; E. F. Jones, manager; (*second row, left to right*): G. B. Blatt, finance; G. R. Tucker, bylaws; H. W. Sommer, Jr., Philadelphia Technical Society Council; G. W. Gordon, secondary schools; A. H. Sellers, Philadelphia Technical Service Council; R. G. Lex, Jr., manager; O. M. Salati, chairman, Science, Electronics, and Instrumentation Technical Division; J. J. Bonk, chairman, Power and Application Technical Division; R. Mayer, papers and meetings; W. P. Magee, membership; (*third row, left to right*): G. C. Mergner, inspection trips; W. S. Kirkpatrick, fellowship and attendance; B. S. Weinfield, public relations; J. L. Weare, transfers; T. H. MacCauley, radio; S. Charp, Solid-State Circuits Conference; S. R. Folger, assistant to treasurer; R. E. Murray, assistant to secretary; C. A. Heintz, registration of engineers; L. S. Heins, publicity.

AIEE Lehigh Valley Section

MEMBERS of the Lehigh Valley Section 1959-1960 Board of Managers are (*seated, left to right*): A. J. Fladd, E. Hansen, J. C. Engle, Jr., M. F. Rosol, J. C. Gray, J. K. McDonald, R. L. Rinehart; (*standing, left to right*): R. L. Holland, R. H. Demmy, W. F. Mackenzie, H. A. Tooker, R. S. Egge, E. P. Winkelspecht, D. Y. Brouse, W. F. Pflum, R. E. Frick, J. E. Roth, H. R. Steward, R. B. Roush, J. S. Stetler, W. F. Dunkle, J. Goodman, H. W. Leas, V. F. Stuebner. Incoming chairman is M. F. Rosol. Other incoming officers include J. C. Engle, Jr., A. W. Plonsky, and J. C. Gray, vice-chairmen; J. K. McDonald, secretary-treasurer; and E. F. Reis, assistant secretary-treasurer.


1. EJECT HEAT COVER EXPOSING PARACHUTE COMPARTMENTS
2. EJECT PARACHUTE TO DECELERATE VEHICLE
3. PARACHUTE DEPLOYS AND SLOWS VEHICLE TO TERMINAL VELOCITY
4. INNER PORTION OF RECOVERY ASSEMBLY IS SEPARATED FROM RE-ENTRY VEHICLE ALLOWING BALLOON TO BE INFLATED AWAY FROM HOT SURFACE OF VEHICLE. EJECT SOFAR BOMB, RADAR CHAFF, LOCATION AIDS, AND SHARK REPELLANT IN SOLUTION
5-6. AFTER COMPLETION OF INFLATION BALLOON IS UNTETHERED AND ALLOWED TO FLOAT ABOVE PARACHUTE
7. WATER-ENTRY; BALLOON PROVIDES BUOYANCY; RADIO AND LIGHT BEACON BEGIN OPERATION; DYE DISPERSION
OPERATION OF A SEARCH AND RECOVERY SYSTEM FOR RE-ENTRY VEHICLES
AS DEVELOPED BY GENERAL ELECTRIC'S MISSILE AND SPACE VEHICLE DEPARTMENT

ACTUAL RE-ENTRY into the earth's atmosphere is the prime test of the nose cone. At this point it has to withstand destructive forces greater than any yet encountered by an airborne system. Because of this, complex parachute recovery systems are necessary. This subject was discussed on the Philadelphia Section's radio program "Meet the Engineer."

Re-entry Vehicles Discussed on Program "Meet the Engineer"

Five Thor-Able re-entry vehicles have recently been fired. It is not enough to have each vehicle and its payload survive just re-entry; it must also survive atmospheric impact, and then it must be located. In the case of high degree instrumentation and search recovery, components must survive the 40,000 g impact when it enters the water—a thousand times greater than the impact of an automobile crashing into a concrete wall at 40 miles per hour. This is one of the reasons why complex parachute recovery systems are necessary.

Tom MacCauley, chairman of "Meet the Engineer" Radio Committee of the AIEE Philadelphia Section and member of the AIEE Public Relations Committee, made arrangements for the broadcast of two 15-minute discussions entitled "The Nose that Knows." His guest was Mark Morton, manager of re-entry vehicle project of the missiles and space vehicle department of the General Electric Company (GE). Mr. Morton discussed the Thor-Able re-entry vehicle and the "stable" of such vehicles which are being developed by GE Co. He told how these flights have pointed the direction for future design work with higher performance vehicles. As research into new and already existing technologies continues to increase man's knowledge of conditions and problems in connection with manned and unmanned space flight, the "three M's" may be possible—that is mice, monkeys, and now men.

Who call tell what the future may bring. Will our peaceful dreams become realities? It seems conservative to assume that the peacetime missiles will be of the re-entry type.

These presentations were made up into two 15-minute radio broadcasts which were presented on the program "Meet the Engineer" over station WFLN, Philadelphia, Pa., on August 8 and 22.

LISTENERS to "Meet the Engineer" radio program heard two discussions of the Thor-Able re-entry vehicle. Shown are: Mark Morton *(left)*, manager of the re-entry vehicle project, missile and space vehicle department, General Electric Company, who explained the ablation material of the nose cone and its construction to Louis Percey *(center)* and Tom MacCauley *(right)*, chairman of the broadcast.

Wear Your ◆ AIEE Badge

MEMBERS of the AIEE Pulp & Paper Subcommittee who attended the Conference are *(front row, left to right)*: Sigvald Andersen, West Virginia Pulp & Paper Company; S. J. Campbell, Westinghouse Electric Corporation; J. S. Kirkland, Rome Kraft; C. H. Hudson, Jr., Subcommittee chairman, General Electric Company; C. L. Eletson, Subcommittee secretary, Alton Box Board Company; S. A. Bobe, Westinghouse Electric Corporation; D. C. Pier, Beloit Iron Works; T. K. Likos, Westinghouse Electric Corporation; *(back row, left to right)*: M. L. Perkins, Fraser Paper Company; R. J. Farrell, Reliance Electric and Engineering Company; J. D. Grady, Oxford Paper Company; W. H. Buford, Continental Can Company, Inc.; E. H. Overby, Union Bag & Paper Corporation; C. B. White, Jr., Allis-Chalmers Manufacturing Company; G. E. Shaad, General Electric Company; J. M. Yarbrough, Mead Corporation, and M. J. Osborne, Bowaters Southern Paper Corporation.

Annual Conference on Pulp and Paper Industry

The 5th Annual Conference on Electrical Engineering as applied to the Pulp and Paper Industry was held June 18-19, 1959, in the Louis Oakes Room of the Library Building on the University of Maine campus. This Conference was attended by 150 ranking electrical engineers from the mills and allied industries. Attendance was from widespread areas and included mill electrical engineers from as far away as Florida, Minnesota, and Texas.

The 2-day Conference was highlighted by an interesting program of technical papers and timely addresses.

Addresses of welcome were given by Prof. W. J. Creamer, of the University's School of Electrical Engineering, and Prof. L. C. Jennings, School of Chemistry.

Dr. J. L. Ober, president, University of Maine Pulp and Paper Foundation, gave a luncheon address at Stoddard Hall, June 18. Dr. Ober explained how the University of Maine prepares young aspirants for high level positions in the pulp and paper field by offering specially selected courses beyond a B.S. degree, which lead to a certificate denoting administrative ability in this field. Dr. Ober stated that this practice was being enthusiastically endorsed by the Foundation, which consists of many mills and allied organizations, and is directed by top level executives from these organizations.

John Gould, well-known author and lecturer, addressed the banquet held the evening of June 18, at the Penobscot Valley Country Club. Mr. Gould pointed out contributions to our early American history made by the State of Maine.

Among universities, Maine has probably one of the few complete paper machines, which is used in their research work on pulp and paper. This is a Fourdrinier-type machine, approximately 11 inches in width, operating about 300 feet per minute. Laboratories were opened to inspection. Many mills within practical driving distance opened their doors to visits by those attending the Conference.

The AIEE Pulp and Paper Subcommittee meeting was held June 17, when it was determined that the 1960 Conference would be held in Gainesville, Fla., probably during early or mid-April. The meeting to be held in 1961 is planned for the midwestern states area.

Much of the success of the 1959 Conference may be attributed to the excellent co-operation and assistance provided by the University's Colleges of Engineering and Chemistry, and to the Publicity Department, under the direction of Howard Keyo.

The program on Thursday, June 18, consisted of presentations describing "Short Circuit Calculating Boards," "Great Northern Paper Company's Power System," "Magnetic Amplifier Power Supplies for Adjustable Speed Drives," "Control Systems for Industrial Nuclear Power Plants," and "High-Voltage A-C Motor Insulation."

The subjects covered June 19 were "Lightning Protection for Paper Mills," "Cable Application in Paper Mills," "Regulating Systems for the Paper Industry."

Copies of the papers presented are not available until released through AIEE Headquarters and the authors' consent given.

C. H. Hudson, General Electric Company, Atlanta, Ga., is chairman of the AIEE Pulp and Paper Industry Subcommittee. E. K. Murphy, Rayonier Incorporated, Jessup, Ga., is vice-chairman, and C. L. Eletson, Alton Box Board Company, Alton, Ill., is secretary.

Plans for Commemoration of AIEE's First Technical Meeting

Members of the AIEE Philadelphia Section will meet at the Franklin Institute in that city on October 7, 1959, to commemorate the AIEE's first technical meeting held at Philadelphia 75 years ago, on October 7, 1884.

After a reception and dinner, guest speakers will review some of the past accomplishments of the AIEE. They will also predict some of the outstanding things to come as a result of work now being done in the field of electrical engineering.

L. F. Hickernell, AIEE's 1958-59 national president, will dust off the organization's old records and review its past history at the October meeting.

Vice-Admiral J. T. Hayward, Deputy Chief of Naval Operations (Development), and Brigadier General David Sarnoff are scheduled to give the members of the Philadelphia Section a glimpse of what the future has in store for the electrical engineer.

At the meeting, current AIEE National President J. H. Foote will announce the creation of the General Sarnoff Medal which will be awarded for outstanding achievements in the field of electronics.

R. S. Hewett, chairman of the Philadelphia Section, will act as master of ceremonies at the organization's 75th Birthday Meeting.

In addition to the members, R. L. Halberstadt, chairman of the 75th Anniversary Committee, is making plans for some 300 guests who are expected to attend the celebration which is being held as part of the joint meeting with the Franklin Institute.

EJC To Publish Newsletter on Activities

In its expanding service to the nation's engineers and its own member societies, Engineers Joint Council (EJC) will publish *Engineer*, a newsletter report on EJC activities, national affairs, and events which affect the engineer, with the first issue scheduled for September 1959. *Engineer* will appear nine times a year.

In addition to reporting EJC's actions on behalf of engineering, the newsletter will cover national legislative, administrative, and legal events of importance to the engineer. The publication will make available advance notices of EJC's periodic reports in such areas as manpower, engineering salaries, engineering college enrollment, military service for trained manpower, and international events.

The newsletter will bring together news emanating from many sources into a single, comprehensive digest for engineers.

Distribution of *Engineer* will be free and will be available to responsible persons and organizations in industry, Government, and education. Address Engineers Joint Council, 29 W. 39 St., New York 18, N. Y.

Plans Nearing Completion for National Power Conference

The General Arrangements Committee composed of members of the Kansas City Sections of AIEE and the American Society of Mechanical Engineers (ASME) have announced that plans for the 1959 National Power Conference are nearing completion.

The Conference, jointly sponsored by the Power Divisions of AIEE and ASME with the co-operation of the local sections of both societies, will take place September 28–October 1, 1959, in Kansas City, Mo. Sessions will be held in the Municipal Auditorium adjacent to the Muehlebach Hotel which will serve as headquarters hotel.

Among the highlights of the social schedule will be two luncheons scheduled for Monday, September 28, and Wednesday, September 30. The main address at the Monday luncheon will be presented by G. B. Warren, president, ASME. The Wednesday luncheon will be highlighted by an address by J. H. Foote, president, AIEE.

Several plant trips to nearby industrial sites have been planned. Included are trips to the Montrose Station of the Kansas City Power and Light Company, and the Plotte Pipeline Company control headquarters.

The Technical Program Committee has announced that six technical sessions have been scheduled with three sponsored by ASME and three sessions by AIEE. Included in the ASME program will be a session on High-Temperature Steam Generation with a paper outlining the historical background of the ASME Research Committee on High-Temperature Steam Generation.

Only numbered ASME papers in this program are available in separate copy form until July 1, 1960. Copies can be obtained from the ASME Order Department, 29 W. 39th St., New York 18, N. Y. Prices are 40¢ each to members of ASME; 80¢ to nonmembers. Payment may be made by check, U. S. postage, free coupons, or coupons purchased from ASME. The coupons, in lots of 10, are $3 to members and $6 to nonmembers. Papers must be ordered by the paper numbers listed in this program otherwise the order will be returned. The final listing of available technical papers will be found in the issue of *Mechanical Engineering* containing an account of the Conference.

Copies of numbered AIEE papers can be obtained by writing directly to AIEE, 33 W. 39 St., New York 18, N. Y.

The tentative technical program follows:

Monday, September 28

9:00 a.m. Session I

Cooling Towers—Automatic Control of Water Quality. *J. T. Kintigh*

Cooling Towers—An Alternate Method of Fan and Auxiliary Control. *R. J. Davis*

Loud Speakers Communication in Power Plants. *A. W. Goldman*

Low-Cost Provisions for Synchronous Condenser Operation of New Willow Island Unit No. 2. *R. D. Brown, A. C. Kelsall* (AIEE Paper No. CP59-1066)

2:00 p.m. Session II

The Power Test Codes for Steam Turbines, Including a New Procedure for Simplified Performance Tests. *O. D. Whiddon*

Fifteen Years Experience Employing Simplified Performance Tests to Follow Plant Efficiency. *F. H. Light, J. H. Daniels*

The Power Test Codes and Bench Mark Testing. *T. Baumeister*

Bench Mark Testing in Industrial Power Plants. *L. J. Brown*

Panel Discussion

Tuesday, September 29

9:00 a.m. Session III

Historical Background of the ASME Research Committee on High-Temperature Steam Generation. *H. L. Solberg*

Metallurgical Evaluation of Superheater Tube Alloys after 6 Months Exposure at Temperatures of 1100 F to 1500 F. *C. L. Clark, J. J. B. Rutherford, A. B. Wilder, M. A. Cordovi* (ASME Paper No. 59-PWR-1)

High-Temperature Alloy Considerations in Superheater Designs. *P. M. Brister, G. N. Emmanuel*

High-Temperature Alloy Considerations in Steam Turbine Designs. *N. L. Mochel*

Summary by *J. H. Harlow*

2:00 p.m. Session IV

Operation of Steam Turbines to Minimize Shell Cracking. *R. L. Jackson, S. B. Coulter*

Minimum Recommended Protection for Unit Connected Steam Stations. (An AIEE Committee Report, Paper No. 59-1149)

Current Practice in Control and Interlocking a Gas-Fixed Boiler Turbine Generator Unit. *E. H. Finch*

Wednesday, September 30

9:00 a.m. Session V

Outline of the Problem of Peak Power Supply. *R. W. Dodson*

An Approach to Peak Load Economics. *Galloway, Kirchmayer, Marsh, Mellor*

Steam Power Plants for Peaking Service. *A. LeBailly*

2:00 p.m. Session VI

A Paper on the Design of Montrose Station. *F. A. Ritchings, W. E. Slemmer*

The Power Mine and Coal for Montrose Station. *J. R. Jones*

Montrose Steam Electric Station Operating Experience. *G. A. Meyers*

Activities of the AIEE Montreal Section

At the annual meeting of the Montreal Section of AIEE, the following officers were elected for the 1959-60 Season: Chairman of the Section—Paul Rose, Canadian General Electric Co., Ltd.; Chairman Program Committee—H. O. Wilson, The Shawinigan Engineering Co., Ltd.; Secretary-Treasurer—L. Swift, Canadian Hoosier Engineering Co., Ltd.; Chairman Membership Committee—R. L. Gladwell, Aluminum Company of Canada, Ltd.; Executive Committee—T. F. Palmquist, The Bell Telephone Company of Canada; G. Perron, Quebec Hydro-Electric Commission; J. Thibeault, Southern Canada Power Co.; A. H. Elliott, Canadian Westinghouse Co., Ltd.

At the same meeting, the results of the Prize Paper Contest were announced, and prizes awarded.

The first prize of $50 and certificate was awarded for a paper entitled "The St. Lawrence River High-Voltage Submarine Cable Crossing," submitted by: D. M. Farnham, Hydro-Quebec; S. H. Cunha, Hydro-Quebec; G. B. Shanklin, consulting engineer; H. D. Short, Canada Wire & Cable Co., Ltd.

Second prize of $30 and certificate was awarded for a paper entitled "Evaluation of the Internal Insulation of Generator Coils Based on Power Factor Measurements," submitted by: D. A. Findlay, R. G. Brearley, C. C. Louttit, all of Aluminum Company of Canada, Ltd.

Third prize of $20 and certificate was awarded for a paper entitled "Bersimis 300-Kv Transmission System," submitted by: Lionel Cahill, Hydro-Quebec.

Photo Illustrations of Canada

OFFICERS, at the annual meeting of the Montreal Section are *(left to right)*; R. L. Gladwell; P. E. Rose, chairman-elect; Prof. G. F. Tracy, vice-president, District No. 10; E. D. Bent, chairman, Montreal Section; Dr. R. Dupuis, vice-president-elect, District No. 10; H. O. Wilson, chairman, program committee; and R. A. Boyd, past chairman, Montreal Section.

Announcement Made of Whitehead Insulation Award

A new award, which is in the process of being established, will be called the J. B. Whitehead Electrical Insulation Award. It will honor the memory of Dr. Whitehead, past president of AIEE in 1933-34, who contributed greatly toward recognition of the insulation field as a separate area of science and engineering.

To establish the award, it is necessary that $25,000 be raised. This fund will be invested conservatively to yield a return which will cover the costs of a $500 cash award, medal, and certificate each year. When the required endowment fund is raised, it will be turned over to some well-known tax-free organization for administration. Definite rules will govern the selection of the individual to receive the award each year but it is intended that the awardee be selected entirely on the basis of his achievements in the insulation field —he will not need to be a member of any particular professional society or group to qualify for the award.

Checks or money orders may be made payable to the J. B. Whitehead Electrical Insulation Award Fund and sent to Prof. F. Hamburger, Jr., Electrical Engineering Department, Johns Hopkins University, Baltimore 18, Md.

Requests for further information should be directed to the fund chairman, Dr. L. J. Berberich, Manager, Engineering Department, 9L51, Associated Companies Division, Westinghouse Electric International Co., East Pittsburgh, Pa. Other members of the committee are: H. H. Chapman, Jr., Owens-Corning Fiberglas Corp.; K. N. Mathes, General Electric Company; Prof. Hamburger; J. R. Perkins, E. I. du Pont de Nemours & Co. (Inc.), and L. R. Samelson, Lake Publishing Corp.

Dr. Whitehead served as chairman of the Conference on Electrical Insulation of the National Research Council from 1922 to 1939. He founded the School of Engineering at Johns Hopkins University and became its first dean in 1919, serving in this capacity until 1938 when he became director. He was named professor emeritus when he retired in 1942.

Fondation Montefiore 1960 International Competition

A prize, to be awarded every 5 years, will be bestowed by means of an international competition, on the best original work submitted on scientific advance and progress in the technical applications of electricity in all spheres, excluding popular treatises or compilations.

Only those works submitted during the 5 years preceding the meeting of the Board of Examiners will be considered for the award. They must be written in French or English, and may be printed or typewritten and, in either case, the examiners may decide to print them.

Eight copies of each work must be submitted, whether printed or typewritten. They should be sent, postage paid, to Monsieur le Secretaire-Archiviste de la Fondation George Montefiore, 31, Rue St. Gilles, Liege, Belgium.

AIEE Cleveland Section

THE CLEVELAND SECTION of the Institute recently held their annual election of officers. The newly elected officers are *(left to right)*: Chairman E. C. Barnes, Reliance Electric and Engineering Company; Vice-Chairman A. J. Hornfeck, Bailey Meter Company; Secretary H. Caruso, Cleveland Electric Illuminating Company, and Treasurer J. R. Wickey, Clark Controller Company.

The 1960 prize will be 100,000 Belgium francs, and the closing date for receipt of works by the Board of Examiners has been set at July 1, 1960. The works presented should be clearly and prominently headed, "Travail, Soumis au Concours de la Fondation George Montefiore—Session de 1960."

Dr. P. A. Abetti, manager of Project EHV, General Electric Company, won this prize in 1955 for a paper on the study of transient phenomena by means of electromagnetic models.

For further information, write to Monsieur le Secretaire-Archiviste at the aforementioned address.

Engineers To Confer on Magnetohydrodynamics

The Basic Sciences Committee of the AIEE is sponsoring a conference on the engineering aspects of magnetohydrodynamics to be held at the University of Pennsylvania, Philadelphia, Pa., February 18-19, 1960. The program, which is mainly concerned with high-energy gaseous plasmas, will be divided into four sessions, none of which will be concurrent.

Program divisions and members of the Program Committee are: Fusion—Prof. N. Mather, Princeton University; Power Conversion—Prof. H. Yeh, University of Pennsylvania; Flight Applications—Prof. E. Resler, Cornell University and Communications and Diagnostics—Prof. L. Goldstein, University of Illinois.

It is intended that the Fusion Session deal with the engineering problems relating to the extraction of energy from the thermonuclear fusion of light nuclei; the Power Conversion Session, with the direct extraction of electric energy from hot, flowing ionized gases or liquids; the Flight Applications Session, with the propulsion or control of aerodynamic vehicles or satellites by magnetohydrodynamic interaction between the vehicle and its environment, and the Communications and Diagnostics Session, with the transmission and receipt of energy or information from high-energy gaseous plasmas under various conditions.

The primary purpose of the meeting is to exchange information on more or less related disciplines with the assumption that the participants will have some degree of competence in one or more of the broad areas. Each session will open with one or more invited review papers followed by contributed papers accepted by the Program Committee. The authors of papers should assume audience familiarity with the field, and concentrate on what is original and novel in their particular contribution.

Papers should not exceed 20 minutes in length. They can be substantially shorter, of course, if content so indicates. The proceedings of the symposium will not be published. Publication of the abstracts, or of condensed versions of the abstracts, to be circulated prior to the meeting is under consideration. This should not preclude later publication of the entire paper in the appropriate professional journal. Abstracts (800 words in length) should contain an appropriate bibliography, and must be in the hands of the Program Committee no later than November 15, 1959, to obtain consideration. For further information, write to: Clifford Mannal, Aerosciences Laboratory, Missiles and Space Vehicle Department, General Electric Company, 3750 D-Street, Philadelphia 24, Pa.

New Officers Elected by St. Louis Joint Council

The Joint Council of the Associated Engineering Societies of St. Louis, Mo., at its annual meeting June 17, elected the following officers for the 1959-60 year: President, H. E. Frech, Jr., Olin Mathieson Chemical Co.; Vice-President, E. G. Mathae, Harnischfenger Corp.; Secretary-Treasurer, G. F. Herold (M '56), Rebmann Gay Herold, Consulting Engineers.

The Joint Council represents approximately 7,500 engineers and those associated with the profession including architects. These are the members of the following member-societies: Engineers' Club of St. Louis and St. Louis Sections of AIEE, American Institute of Architects, American Institute of Chemical Engineers, American Institute of Industrial Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, American Society of

Quality Control, American Society of Civil Engineers, American Society of Heating and Air Conditioning Engineers, American Society of Mechanical Engineers, American Welding Society, Illuminating Engineering Society, Institute of the Aeronautical Sciences, National Association of Corrosion Engineers, Society of American Military Engineers, Instrument Society of America, and American Society of Refrigeration Engineers.

Call for Papers Winter General Meeting

The AIEE Computing Devices Committee and Digital Computer Subcommittee have announced submission dates for papers for the 1960 Winter General Meeting, New York, N. Y., January 31-February 5.

Prospective authors are invited to submit papers on significant work on control computers such as the following:

1. Definition and characterization of problems for control computers
2. New control computers
3. Comparison of different computers or computer types for a single application
4. Criteria for selecting computer types for control applications
5. Techniques and concepts of the future

In addition to papers on new developments and fundamental studies, tutorial papers on control computers are invited. Special emphasis will be placed on delineating areas of usefulness of incremental (DDA) and whole-number general-purpose (GP) computers for control applications.

Abstracts of prospective papers are needed almost immediately to allow for the selection and preparation of the program for these special sessions. Strict adherence to the following schedule is essential:

September 15—Deadline for receipt, in triplicate, of a 50- to 100-word abstract and a 500-word summary of the paper for program planning.

November 2—Deadline for full text of *Transactions* papers prepared in accordance with the AIEE Author's Guide.

December 2—Deadline for full text of conference papers. (preprints only)

All correspondence concerning these special sessions should be addressed to: G. L. Hollander, Chairman, c/o Philco Corporation, 4700 Wissahickon Ave., Philadelphia 44, Pa.; or R. J. LaManna, Paper Chairman, c/o Monroe Calculating Machine Co., 555 Mitchell St., Orange, N. J.

Announcement Made of 1960 John Fritz Medalist

G. A. Price (AM '47), chairman and president of the Westinghouse Electric Corporation, Pittsburgh, Pa., has been designated the recipient of the John Fritz Medal for 1960.

The citation reads ". . . for his inspirational leadership, industrial pioneering and personal initiative in marshaling the creative forces of research and engineering to the cause of developing atomic power for the national defense and for the human welfare."

AIEE Cincinnati Section

THE CINCINNATI SECTION OF AIEE recently held their annual Student Prize Thesis Competition for seniors at the University of Cincinnati. This year's winners and the committee members are *(left to right)*: Prof. Carl Evert, Student Branch adviser; J. C. Neupauer, chairman, Annual Award and Prize Paper Committee; J. R. Rae, speaker for the meeting; H. W. Deaton, first prize winner; J. M. Walter, second prize winner; A. C. Varner, third prize winner; and Prof. A. C. Herweh, head, electrical engineering department, University of Cincinnati.

Textile Meeting Scheduled, October 15-16, Charlotte, N. C.

The AIEE Textile Industry Subcommittee together with the AIEE North Carolina section and North Carolina State College are sponsoring a Textile Conference in Charlotte, N. C., October 15-16, 1959. Headquarters is the Hotel Charlotte.

The program for the Conference follows:

Thursday, October 15

10:00 a.m. Registration—lobby, Hotel Charlotte

11:00 a.m. Luncheon Period

1:30 p.m. Afternoon Session

Presiding: E. R. Davis, Duke Power Company

Address of Welcome: W. B. McGuire, president, Duke Power Company

New Motor Insulations for the Textile Industry. *L. P. Gregory*, Allis-Chalmers Manufacturing Company.

Lighting as a Production Tool. *E. A. Lindsay*, General Electric Company

The Disease Called Power Factor and How Capacitors Can Profitably Cure This Disease. *H. J. Forbes, Sr.*, Celanese Corporation

4:15 p.m. Committee Reports and Announcements

6:00 p.m. Social Hour

7:00 p.m. Dinner

Friday, October 16

9:30 a.m. Morning Session

Presiding: George Watson, The Kendall Company

Electrical Control for Dual Fuel Small Boilers. *P. K. Ryder*, Electronics Corporation of America

Co-ordinating Drive Characteristics with Load Requirements. *C. G. Helmick*, Westinghouse Electric Corporation

Some Do's and Don't's of Electrical Grounding in a Textile Plant. *L. S. Inskip*, Bell Telephone Laboratories, Inc.

12:30 p.m. Luncheon—Hotel Charlotte

Presiding: M. J. Mulhern, chairman, North Carolina Section

Speaker: North Carolina Nuclear Energy Program. D. M. McConnell, general counsel, Belk's Stores

2:00 p.m. Afternoon Session

Presiding: H. E. Strock, E. H. Gilliam Co.

Textile Machinery Drives in Europe. *John Bina*, Dominion Textile Company

Value of Long-Range Planning in the Design of Electric Distribution Systems for Industrial Plants. *W. P. Lyman*, Carolina Power & Light Company

Technical Periodicals

The technical periodicals, *Communication and Electronics, Applications and Industry*, and *Power Apparatus and Systems* contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis issued six times a year. Members may receive one subscription to any *one* of the technical periodicals for $2.50. The balance of the annual $5.00 subscription price will be paid by application of his annual dues for the year of the subscription. (Members may not reduce the amount of their dues payment by reason of nonsubscription.) Additional member subscriptions will be at the rate of $5.00. Nonmembers may subscribe on an advance annual subscription basis of $8.00 each (plus 50¢ extra for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.50 each. Discounts are allowed to libraries, publishers and subscription agencies.

SEP Celebrates 40th Anniversary

The Polish Association of Electrical Engineers (SEP) celebrated its 40th Anniversary during the Annual SEP Convention held in Warsaw, Poland, June 8-14, 1959. Over 2,000 members of the SEP and guests from 12 foreign countries participated in the convention. The AIEE was represented by Dr. J. J. Podoski (M '41), who had served as secretary general of the SEP before the war for 10 years.

General Session

The meeting chairman, Dr. Jan Podoski, professor of electric traction and dean of the electrical faculty, Polytechnical Institute of Warsaw, opened the general session held Thursday afternoon at the Congress Hall of the Palace of Culture and Science. He greeted the members of the Polish Government present at the meeting and introduced the speakers. All speeches were simultaneously translated into English, French, German, Polish, and Russian.

Dr. Podoski, as representative of the AIEE, gave a welcoming speech to the assembly in which he quoted President L. F. Hickernell's remark at the 75th Anniversary Celebration of the AIEE: "An anniversary is a truly happy event when the promise of the future outweighs the accomplishments of the past." He then pointed to some past and recent achievements and to the "promises of the future," which, however, can never be fulfilled if the scientists and engineers of many lands fail to do what is their duty, namely to serve humanity for the good of all. "This is the nuclear age," said the speaker, "which either takes us to the stars and toward untold happiness—or throws us into complete annihilation. We the scientists and engineers hold the keys to that future. We can, and we must, use those keys to open the path to a better life for all, to a life of plenty, so that our children, and our children's children all over the world will be forever free—free from want, free from fear, and free from lack of freedom."

With greetings from the President and Members of the Institute, he then presented to the President of the SEP two bound volumes of the anniversary issue of *Electrical Engineering*, inscribed for presentation and signed by President Hickernell.

The keynote address was presented by Prof. Dr. J. L. Jakubowski, member of the Polish Academy of Sciences, on "The Role of Electricity in the Economic Life of the Country." He gave a summary of developments in the science of electricity and electrical engineering in Poland from 1919 until the present. He then went on to describe plans for the immediate future included in the general economic plan for Poland.

After the addresses, some members of the SEP were decorated with SEP merit pins and with State decorations.

Technical Sessions

From June 9-12 inclusive, technical sessions were held. Included among the papers presented were several reports by Polish committees on subjects such as: electric heating, lightning protection, fluorescent lamps for external illumination, automatic control of power plants, automation, rural electrification, telecommunications, and electric traction.

The convention represented a coming together of Poles and representatives of the East and West where the common language was volts and amperes. Visitors could see and appreciate the efforts of a brave and industrious nation, which, despite the ravages of war, is struggling to build a better future for the generations to come.

AT THE OPENING SESSION of the Polish Association of Electrial Engineers (SEP) Convention are shown *(first row, left to right)*: Karel Kvet, chairman, electrical engineering section of the Scientific-technical Society of Czechoslovakia; Marin Kalburow, vice-chairman, Scientific-technical Society of Bulgaria; Dr. J. J. Podoski, of Washington, D. C., AIEE representative at the convention; Robert Davis, The Institution of Electrical Engineers, London, England; Prof. Janusz Groszkowski, first vice-president of the Polish Academy of Sciences; Dr. Jan Podoski *(standing)*, dean of the electric faculty, Polytechnical Institute of Warsaw, and chairman of the SEP 40th Anniversary Committee, and Prof. I. S. Stekol'nikov, member, Academy of Sciences, USSR.

Conference on Electrical Techniques in Medicine, Biology

The 12th Annual Conference on Electrical Techniques in Medicine and Biology will be held in the Sheraton Hotel, Philadelphia, Pa., November 10-12, 1959. This Conference is sponsored by AIEE, the Institute of Radio Engineers (IRE), and the Instrument Society of America (ISA). Electromagnetic radiation effects will be explored at the electromedical meeting.

Although the profound effects that penetrating radiation (such as X rays) have upon living systems have been studied intensively for some time, comparatively little is known about similar effects of radiation of other wavelengths, ranging from the subsonic and ultrasonic through the infrared and ultraviolet.

This vital problem has been adopted as the theme for the Conference, during which specialists will report on the application of radiation of all wavelengths for diagnosis, therapy, and research investigation. During a 3-day program, this subject will be discussed by international authorities in the field in a series of invited papers. There will also be submitted papers on the subject as well as on other subjects related to electrical and electronic techniques in biology and medicine.

The Conference will also feature an exhibit and demonstrations of the latest electromedical equipment and accessories. Among the products that will be displayed are microphotographic systems, intracardiac phonocatheters, blood gas analyzers, fetal heart pickups, cardiodynameters, electronic goggles, continuous blood pressure and pulse-rate monitors, wide-band amplifiers, laboratory and student stimulators.

Another feature will be a series of planned tours to the Johnsville Aero-Medical Acceleration Laboratory (USN), Institute for Cancer Research, Electromedical Laboratory and Johnson Foundation at the University of Pennsylvania, and the Air Crew Equipment Laboratory (USN).

Paper Deadline Extended

In view of the tremendous interest shown in the Conference theme, the deadline for papers has been extended to September 15. Abstracts (500 words) and illustrations should be submitted, on or before September 15, to the Program Committee Chairman: Dr. L. E. Flory, RCA Laboratories, Princeton, N. J.

CORRECTION FOR AUTHORS

Refer to p. 853 of the August 1959 issue of *Electrical Engineering* "Requirements for Authors and Publication Rights for AIEE Papers and Articles."

Item 4 under "Submission" should read "Abstract 80 days prior to day of presentation."

Item 5 under "Submission" should read "65 days prior to date of meeting."

Power Plant Instrumentation and Automatic Operation

As an innovation, the Power Generation Committee of the AIEE held two ½-day technical sessions in combination with committee meetings in Chicago, Ill., April 27-28, 1959.

According to C. F. Paulus, who was in charge of arrangements, the experiment was quite successful, from the viewpoint of attendance as well as active participation.

Five informal presentations were made concerning various aspects of power plant instrumentation and automatic operation. This includes scanning, logging, alarming, computation, recording, annunciation, sequential operation, integrated control, digital readout, and automatic start-up and shut down of units.

Great strides in technology and acceptance of new concepts have been made in this field in the last 3 or 4 years. Many installations, of varying degrees of sophistication, are already in service in utility and process industry applications. Technology has advanced to the point where automatic start-up and shut down, operation, performance monitoring and computing for efficient operation, sequential recording, and other phases of this subject are in service or in design stages at this time.

All agreed that economic justification of these systems is very difficult and is the major stumbling block for utility application; manpower savings or replacement of existing equipment usually cannot be obtained. The latter may be possible after several years of extended operation have proved the reliability of new equipment to the point where conventional meters, recorders, and annunciators may be eliminated.

However, the complexity of modern large units in some cases may require the use of these approaches regardless of cost. In addition, work must get underway in developing and proving these techniques to anticipate the time when they are essential for all large units. Often, the most potent arguments for their use at present is the prestige value of having sophisticated computers and advancing the state of the art.

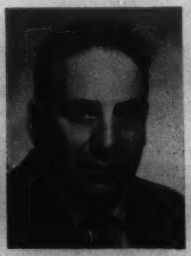
Because of the rapid advances being made, it was agreed that it is essential for all to keep abreast of this advancing field, even though engineers find more complex devices difficult to justify economically at the present. The spirited discussion following each of the presentations showed that everyone is having difficulties of this type. Continued co-ordinated action is required by committee members and, in particular, the new Working Group on Instrumentation and Data Handling.

AIEE FELLOWS ELECTED

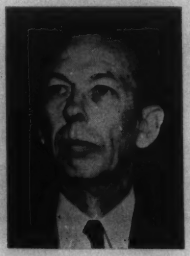
Board of Directors Meeting, June 26, 1959

Leonard Gladstone Abraham (M '39), director of transmission engineering, Bell Telephone Laboratories, Inc., Murray Hill, N. J., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the engineering and development of long distance television transmission systems." Mr. Abraham was born in Watson, Ill., September 25, 1901. He received B.S. and M.S. degrees from the University of Illinois in 1922 and 1923, respectively. In 1923, he joined the development and research department of the American Telephone & Telegraph Company, which was later joined with the Bell Telephone Laboratories. He has remained with the latter, except for a period from 1952-54 when he was director of electronics for Sandia Corporation in Albuquerque, N. Mex. His work has included systems engineering planning as well as development of specific systems. Mr. Abraham is a member of the Joint Technical Advisory Committee on Tropospheric Scatter Transmission, and of the Executive Committee of the U. S. Preparatory Committee for the 1959 International Radio Committee. He is a member of the American Association for the Advancement of Science, Sigma Xi, and a fellow of the Institute of Radio Engineers. He is a registered professional engineer in New Jersey. He has served on the AIEE Communication Committee (1948-49); Wire Communication Systems Committee (1949-53, chairman 1950-52); Communication Division Committee (1950, 1952-59); Award of Institute Prizes Committee (1952-54); and Communication Theory Committee (1955-59, chairman 1955-56). He is a member of the Special Task Force on Institute Activities and Organization, appointed in late 1957.

L. G. Abraham



Marvin Camras



H. A. Clarke

Marvin Camras (AM '41, M '47), senior engineer, electrical engineering department, Armour Research Foundation, Chicago, Ill., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the science and art of magnetic recording." Mr. Camras was born January 1, 1916, in Chicago, Ill. He received the B.S. degree in E.E. from Armour Institute of Technology in 1940, and the M.S. degree from Illinois Institute of Technology (IIT) in 1942. Since 1940, as a member of the staff at Armour Research Foundation, he has done research on projects in electronics, which included remote control, high-speed photography, magnetostriction oscillators, and static electricity. Mr. Camras' contributions toward the development of modern magnetic tape and wire recorders have included high-frequency bias, improved recording heads, wire and tape materials, magnetic sound for motion pictures, multitrack tape machines, and stereophonic sound reproduction. He is a fellow of the Institute of Radio Engineers (IRE), and the Acoustical Society of America, and a member of the Society of Motion Picture and Television Engineers, the American Association for the Advancement of Science, Eta Kappa Nu, Tau Beta Pi, and Sigma Xi. He has been editor of the IRE Transactions on Audio since 1958. In 1953-54, he was chairman of the IRE Professional Group on Audio (PGA), and vice president of the IIT Chapter, Sigma Xi. He received the John Scott Medal in 1955, and the IRE-PGA achievement award in 1958.

Henry Anable Clarke (AM '21, M '45), superintendent, system station department, Appalachian Power Company, Roanoke, Va., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to carrier current relaying and ultrahigh-speed power circuit reclosing techniques." Mr. Clarke was born June 14, 1896, in Williamsport, Pa. He received the B.S. degree in E.E. from Union College in 1918. He served in World War II as a second lieutenant in the Signal Corps. After the war, he joined the General Electric Company on the test program. In 1920, he transferred to the Philadelphia office. In 1925, he joined the Pennsylvania Water and Power Company as a field engineer on the construction of the Holtwood Steam Power Plant. Later that year, he joined the Kentucky and West Virginia Power Company, a predecessor of the Appalachian Power Company, as an electrical engineer at the Logan Steam Plant. In 1927, he was promoted to relay engineer in charge of the system relay department of the Appala-

J. A. Cronvich

A. C. Dickieson

Marvin Carlson
G. W. Downs

P. G. Edwards

chian Power Company. While he was relay engineer, tremendous advances were made in the art of transmission, which included important developments in high-speed switching, high-speed carrier relaying, and ultrahigh-speed reclosing of transmission lines. As relay engineer of the Appalachian Power Company during this period, he participated actively in these developments. In 1945, he was promoted to system station superintendent. Mr. Clarke is a member of Sigma Xi. He is a past chairman of the AIEE Virginia Mountain Section, and has served on the AIEE Nominating Committee (1959).

James Anthony Cronvich (AM '41, M '49), professor and head, electrical engineering department, Tulane University, New Orleans, La., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to medical practice through electronic applications and to teaching in this area of relationship." Prof. Cronvich was born in New Orleans, La., October 26, 1914. He attended Tulane University, where he received a B.E. degree in mechanical and electrical engineering in 1935, and an M.S. degree in electrical engineering in 1937. He was a General Radio Fellow at the Massachusetts Institute of Technology, and received an M.S. degree in electrical engineering in 1938. He joined the faculty of Tulane University in 1938, as an instructor in electrical engineering. He left Tulane in 1941 to become an assistant and later associate electrical engineer with the Special Engineering Division on the Third Locks Project of the Panama Canal. In 1942, he returned to Tulane as assistant professor to teach and develop the electronics program. He became associate professor in 1944, professor in 1949, and head of the department of electrical engineering in 1956. Since 1946, he has worked on cardiovascular studies with a research group of the department of medicine of the Tulane Medical School. In connection with this work, he has been coauthor of over 20 technical papers and of one monograph, "Spatial Vectorcadiography," published in 1953. He is a senior member of the Institute of Radio Engineers, and a member of the American Society for Engineering Education, the American Federation for Clinical Research, Sigma Xi, and Tau Beta Pi. He has been a member of the AIEE Electrical Techniques in Medicine and Biology Committee (1957). He is chairman of the New Orleans Section of the Institute for the year 1959-60.

Alton C. Dickieson (M '41), director of Transmission Systems Development, Bell Telephone Laboratories, Inc., Murray Hill, N. J., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to long distance multichannel communications and to underwater guidance systems." Mr. Dickieson was born August 16, 1905, in New York City. He studied electrical engineering at Brooklyn Polytechnic Institute. In 1923, he joined the Bell Telephone Laboratories. In 1929, he was a member of the engineering staff of the Fox-Case Corporation, doing experimental work in connection with sound recording on film. In 1930, he rejoined the Bell Telephone Laboratories as a supervisor in charge of a group of engineers who were developing long distance communications systems. During World War II, Mr. Dickieson led the development of carrier telephone communication systems for the Signal Corps, the development of a sonar system for the Navy, and the development of electronic guidance systems for acoustically steered torpedos. For the latter work, he received the Naval Ordnance Development Award in 1945. In 1946, he was transmission systems engineer; in 1948-51, radio systems engineer, and in 1951, director of transmission systems development. In 1954, as director of air defense planning, he was in charge of planning the communication and detection systems used in the first Distant Early Warning stations in the Arctic. Since 1954, he has been director of transmission systems development. He holds 28 patents in the communication field, and is a registered professional engineer in the State of New York. Mr. Dickieson is a senior member of the Institute of Radio Engineers (IRE), and an IRE editorial reviewer since 1954. He has been a member of the Editorial Committee of the Bell System Technical Journal since 1955, and its chairman since 1958. He was a member of the Joint Technical Advisory Committee Subcommittee on Land-Mobile Channel Allocations. He has served on the AIEE Radio Communication Systems Committee (1949-58, chairman 1952-54); Communication Division Committee (1952-54); and District No. 3 Representative on Technical Operations Department (1957-58).

George Wallingford Downs (M '44), vice-president, Applied Physics Corporation, Monrovia, Calif., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to refinement of acoustical and data-evaluating apparatus and systems." Mr. Downs was born in Mount Vernon, S. Dak., January 29, 1911. He attended the California Institute of Technology in 1930-32. In 1935, he was employed by Lansing Manufacturing Company, Los Angeles, and, in 1936, was named chief engineer. He left to accept a position as development engineer for William Miller Corporation, Pasadena. In 1941, he took a leave of absence to work at the University of California on an antisubmarine warfare research program. On this project, he was a physicist, and served as a general consultant on instrumentation problems as well as project supervisor. In 1943, he was transferred to the California Institute of Technology where he served as physicist and project supervisor in charge of instrumentation on a research project which involved the testing and design of torpedoes to be launched from aircraft. In 1945, a large part of this project was transferred to the Manhattan District, Corps of Engineers. For his work on the torpedo project, Mr. Downs was presented with the "Naval Ordnance Development Award." At the end of the war, Mr. Downs returned to the William Miller Corporation as executive vice-president and chief engineer. In 1946, he was one of the founders of Applied Physics Corporation, and in 1948, he was a founder of Research Instrument Corporation. Mr. Downs left William Miller Corporation in 1954. He is a fellow of the Acoustical Society of America, a senior member of the Institute of Radio Engineers, a member of the American Physical Society, and an associate member of American Optical Society. He has served on the AIEE Instruments and Measurements Committee (1950-51).

Paul Griffith Edwards (AM '23, M '28), director of development, Merrimack Valley Laboratory 216, Bell Telephone Laboratories, Inc., North Andover, Mass., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to the development of carrier, cable, and microwave communication systems." Mr. Edwards was born in Careytown, Ohio, February 17, 1901. He attended Ohio State University, and was graduated with a B.E.E. degree in 1924 and an E.E. degree in 1929. He was a Morse operator and wire chief for the Western Union Telegraph

Company in 1919-22. He worked for the American Telephone & Telegraph Company, long lines department, in 1922-24 as a repeater attendant, and in 1924-34 in the department of development and research. From 1934 to the present, he has been employed by the Bell Telephone Laboratories. He has been granted 38 patents in the telephone field, and is the originator of cable fault locating methods. His other activities have included toll signaling, telephone repeaters, carrier systems for open wire and cable, various voice-operated devices, which included compandors, echo suppressors, and radio control terminals. During World War II he was engaged in the development of sonar systems and electronic controls for torpedoes and mines. His present responsibility is the design for the manufacture of transmission systems, which include coaxial cable, microwave, and speech pulse systems. He is a senior member of the Institute of Radio Engineers, and is a member of Eta Kappa Nu, Tau Beta Pi, Sigma Xi, Pi Mu Epsilon, Pi Tau Sigma, and Scabbard and Blade. He has served on the AIEE Membership Committee (1936-39), Aural Broadcasting Systems Committee (1949-50), Wire Communications Systems Committee (1950-56, chairman 1952-54), and Communication Division (1952-54).

Solomon Fishman (AM '28, M '34), professor of electrical engineering, Newark College of Engineering, Newark, N. J., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to mathematical techniques in solving problems and teaching electrical engineering." Prof. Fishman was born March 27, 1903, in Newark, N. J. He received his B.S. degree in E.E. from the Newark College of Engineering in 1927. He began his teaching career in that year at Newark College as an instructor in electrical engineering. Subsequently, he was named assistant professor, associate professor, and professor. During the years 1947-50, he was also a special lecturer at the International Business Machines Corporation. After World War II began, he organized the Engineering, Science, and Management War Training Program for the North New Jersey area. He also served on the National Defense Research Council under the Office of Scientific Research and Development, which made special studies for the military. For his work with this group, Prof. Fishman was awarded a certificate of appreciation from the Federal Government. As a professional engineer, Prof. Fishman is registered in New Jersey and New York, and is a member of the National and New Jersey State Societies of Professional Engineers. At present, he is an examiner for the New Jersey State Board of Professional Engineers. He is a senior member of the Institute of Radio Engineers, and a member of the American Association for Engineering Education, and the Engineers' Council for Professional Development. He is secretary of the New Jersey Engineers Committee for Student Guidance, and belongs to Tau Beta Pi and Eta Kappa Nu.

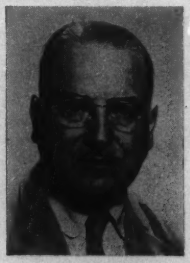
C. J. Fitch

Clyde James Fitch (M '48), senior engineer, advanced technology department, Product Development Laboratory, International Business Machines Corporation (IBM), Endicott, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to electronic machines and to specialized extensions of radio communication." Mr. Fitch was born in Jersey City, N. J., on April 13, 1899. In 1917, he was employed by the General Electric Company, Pittsfield, Mass. In 1923, he became associate editor of *Practical Electrics, Radio News,* and *Radiocraft* magazines, as well as director of the Radio News Testing Laboratory in New York City. In 1931-32, he was editor of the monthly bulletin of the American Interplanetary Society (now American Rocket Society). In 1933, he joined IBM in New York City, and was assigned to work on the development of a radio-controlled electric typewriter. In 1935, he was transferred to the IBM engineering laboratory at Endicott. He was promoted to assistant engineer in 1942, responsible for the design and production engineering of the radiotype system, used by the U. S. Army Signal Corps during the war in its first world-wide teleprinter communications network. In 1943, he was promoted to senior engineer and manager of a department responsible for the development of various electronic devices. In 1952, he was assigned to research and development work on electrostatic devices. He has been granted over 50 patents.

Joseph Wilford Graff (M '46), chief electrical engineer, Alabama Power Company, Birmingham, Ala., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to power system planning." Mr. Graff was born March 5, 1905, in New York City. He received his B.S. degree in electrical engineering at the University of Florida in 1927. After graduation, he accepted employment at the Alabama Power Company. Following a 2-year period of training in the student engineering course, he was assigned to work in the operating engineering department, and later in the production department. During this period, he developed such innovations as an electronic line potential indicator, a self-regulating transformer, and the zero sequence current transformer. He received his certificate as professional engineer in 1936 from the State of Alabama. He was on leave of absence during World War II, during which he served with the U. S. Army Combat Engineers in the European and African theaters. He was discharged in 1945 after he had attained the rank of lieutenant colonel in command of an Engineer Combat Battalion. Upon his return to the Alabama Power Company, his duties involved the co-ordination of engineering and construction schedules and the procurement of the necessary equipment. After the organization of a system planning group, Mr. Graff was assigned to direct its activities. In 1958, he was appointed chief electrical engineer. Mr. Graff is the author of articles on system protection, which were published in the middle thirties, and, since World War II, of technical papers on power system planning. He has served on the AIEE Switchgear Committee (1949-59).

John Scott Jamison, Jr. (AM '38, M '47), professor and head of the electrical engineering department, at Virginia Military Institute (VMI), Lexington, Va., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to engineer-

Solomon Fishman

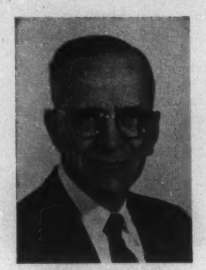


J. W. Graff

J. S. Jamison, Jr.

M. H. Kight

M. G. Lewis



A. M. Lockie

ing education." Prof. Jamison was born at Emlenton, Pa., March 18, 1904. He entered VMI as a cadet in 1922, and was graduated in 1926 with a B.S. degree in E.E. After graduation, he returned to VMI as an instructor in the electrical department. In June 1928, he joined the Westinghouse Electric Corporation. He studied at the company's Engineering School and Electrical Engineering Design School, and served with the company until 1931. The following year he did graduate study, and received his M.S. degree in E.E. from the University of Pittsburgh. He returned to VMI in 1932 as assistant professor of electrical engineering with the rank of major. In 1941, he was appointed associate professor, and, in 1947, was promoted to full professor of electrical engineering with the rank of colonel. He was named head of the department in 1954. He also serves as VMI's director of engineering training. Prof. Jamison is a member of the American Society for Engineering Education. In November 1953, he was named a member of the Virginia State Board for the Examination and Certification of Architects, Professional Engineers, and Land Surveyors, and has served as both president and vice-president of the board. He was reappointed to the board in 1958. He is currently chairman of the Engineer-in-Training Committee of the National Council of State Boards of Engineer Examiners. He has served on the AIEE Registration of Engineers Committee (1955-57).

Max Hamilton Kight (AM '37, M '49), chief of the Electrical Branch, Department of Interior, U. S. Bureau of Reclamation, Denver, Colo., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the establishment of large-scale hydro plants and associated power transmission." Mr. Kight was born in Bluff Dale, Texas, October 26, 1900. He received a B.S. degree in E.E. from the University of Illinois in 1923. He was employed by the U. S. Bureau of Reclamation at Rupert, Idaho, in 1923 as a pumping station operator and electrical assistant, and in 1924 at Denver, Colo., as a junior engineer. Mr. Kight joined the Minnesota Power and Light Company in 1926 as electrical designer of substations and transmission lines. In 1930, he returned to the U. S. Bureau of Reclamation at Denver, Colo., as an engineer, and advanced through a succession of electrical engineering positions in the assistant commissioner and chief engineer's office to the present position of chief, Electrical Branch, in charge of the electrical design of power plants, switchyards, transmission lines, substations, pumping plants, and distribution lines. He has been a member of the International Conference on Large Electrical Systems (1946 to present), and is a registered professional engineer in the State of Colorado. He serves on the AIEE System Engineering Committee (1952-59). He was recently elected to the office of AIEE vice-president for District No. 6.

Melvin George Lewis (AM '36, M '42), executive engineer, Bechtel Corporation, San Francisco, Calif., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to design and construction of large electric plants and installations." Mr. Lewis was born August 9, 1912, in Santa Cruz, Calif. He received the B.S. degree in E.E. in 1935 from Santa Clara University. He has been associated with the Bechtel Corporation since 1947 in the positions of project engineer and chief electrical engineer. In 1953-55, Mr. Lewis entered a partnership of consulting electrical and mechanical engineers in San Francisco, known as Buonaccorsi, Murray and Lewis, in which he was managing partner for the firm and supervisor of all electrical consulting engineering. In 1955, Mr. Lewis returned to Bechtel Corporation as manager of services and executive engineer in their Power Division. Prior to his association with Bechtel, he was employed by Pacific Gas and Electric Company and H. K. Ferguson Company, both of San Francisco, and during 1939-40 was a member of the engineering staff of the Golden Gate International Exposition. He also worked for Austin W. Earl, consulting engineer in San Francisco, where he had complete charge of the preparation of electrical designs and specifications for projects. Mr. Lewis is a registered professional engineer in the States of Nevada, Arizona, and Utah. He served on the AIEE Switchgear Committee (1952-53).

Arthur McLaren Lockie (AM '33, M '43), advisory engineer in charge of long-range major development for the distribution transformer department, Westinghouse Electric Corporation, Sharon, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to thermal analysis of performance and life of loaded distribution transformers." Mr. Lockie was born September 13, 1909, in Buffalo, N. Y. He attended Rensselaer Polytechnic Institute on Rensselaer and New York State scholarships, obtained his electrical engineering degree in 1931, received a special research award for his thesis, and was elected to membership in Sigma Xi fraternity. After teaching electrical engineering and physics at Rensselaer in 1931-36 and obtaining an M.E.E. degree in 1934, he joined Westinghouse in 1936. In 1936-53, he worked on the design, development, and application of circuit breakers, lightning arresters, and other equipment for the protection of distribution transformers. In 1953, he joined the Transformer Division, where he initiated and developed techniques for the functional testing and economic application of distribution transformers. He is the holder of several patents on transformer protective devices, and received a Westinghouse Meritorious Patent Award in 1957. A registered professional engineer, he is a member of the board of directors of the midwestern chapter, Pennsylvania Society of Professional Engineers. Mr. Lockie is the author or coauthor of numerous technical papers and magazine articles on thermal characteristics, life expectancy, and economic use of distribution transformers.

John Alexander Melvin Lyon (AM '38, M '47), professor and chairman, electrical engineering department, Northwestern University, Evanston, Ill., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to engineering education." He was born October 9, 1912, in Saginaw, Mich. He received his B.S. degree in 1933, his M.S. degree in 1934, and the Ph.D. in 1936, all in electrical engineering. Dr. Lyon was employed by the Pittsburgh Reflector Company in 1936, the Metropolitan Edison Company in 1937, and later transferred to the Utility Management Corporation. For the academic year 1937-38, he was also instructor in mechanics for Pennsylvania State College extension. Commencing with the academic year 1938-39, he was instructor in electrical engineering at Johns Hopkins University. In 1942, he took the position of electrical engineer for Ebasco Services, Inc., until he entered World War II service in December 1943 as lieutenant junior grade, U. S. Naval Reserve. Dr. Lyon took preradar training at Harvard University as a naval officer, and then taught in this program. In 1943, he took radar training at the Massachusetts Institute of Technology (MIT). In January 1944, he was assigned to the Radiation Laboratory,

J. A. M. Lyon

MIT, for research and development on "K" band airborne radar. Later that year, he was assigned to the Bureau of Ships, Radar Design Section, Washington, D. C. After World War II, in 1946, Dr. Lyon became assistant professor of electrical engineering, Northwestern University. He was advanced to associate professor in 1947, professor in 1952, and chairman of the electrical engineering department in 1954. He recently resigned from the latter position to become professor of electrical engineering, University of Michigan, as of September 1. Dr. Lyon is a senior member of the Institute of Radio Engineers, a fellow of the American Association for the Advancement of Science, and a member of the American Society for Engineering Education, the Illinois Society of Professional Engineers, the National Society of Professional Engineers, Eta Kappa Nu, Sigma Xi, and Tau Beta Pi. He has served on the AIEE Education Committee (1955-59), Electronics Committee (1945-55), and Power Generation Committee (1939-40).

Michel George Malti (M '45, F '59), professor of electrical engineering, Cornell University, Ithaca, N.Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to electrical engineering education through his teaching and publications." Dr. Malti was born in Deir-el-Kamar, Lebanon, November 7, 1895. He received the B.A. degree from the American University of Beirut, Lebanon, in 1915, the B.S. in E.E. from Georgia Institute of Technology in 1922, the M.E.E. and Ph.D. from Cornell University in 1924, and 1927, respectively. In 1923, he became an instructor in electrical engineering at Cornell University, and has taught there for the last 36 years as instructor, assistant professor, associate professor, and professor. He has done consulting work for Elliott Company in 1927-40, for Upton Electric Furnace Company in 1946-47, for General Electric Company in 1953-54, Cornell Aeronautical Laboratory in 1954-55, and the U.S. Navy on magnetic mines in 1942-43. He is a member of Tau Beta Pi, Eta Kappa Nu, Sigma Xi, and Phi Kappa Phi, and has served on the AIEE Basic Sciences Committee (1936-40, 1945-46, 1948-59, chairman 1950-52), Quarterly of Applied Mathematics Committee (1947, 1949-56), Science and Electronics Division Committee (1950-52), Publication Committee (1954-56), and Student Branches Committee (1954-55).

Clarence Arthur Martin (AM '28, M '45), vice-president, engineering department, Dingle-Clark Company, Cleveland, Ohio, has been transferred to the grade of Fellow in the AIEE ". . . for management of electrical construction for the steel, oil, and chemical industries." Mr. Martin was born September 9, 1894, in Cleveland, Ohio. He received the B.S. degree in E.E. in 1917 from the Case School of Applied Science. In 1917-18, he was a second lieutenant in the U.S. Army. His military training in ballistics as applied to gunfire took place at the Ordnance Engineering School, Aberdeen, Md. His work as appraiser for the Manufacturers Appraisal Company in 1918-19 consisted of general industrial appraisal and special appraisal of electric systems and machinery. During 1919-26, he was successively an engineer, estimator, superintendent, department manager, and vice-president, of the Electrical Construction and Sales Company. In 1926, he was employed by the Dingle-Clark Company as an engineer. He was made general superintendent in 1928, chief engineer in 1934, and vice-president of engineering and a director in 1947. On January 1, the W. W. Clark Corporation assumed all electrical construction operations of the Dingle-Clark Company. Mr. Martin is vice-president of the new company. He is an associate member of the Association of Iron and Steel Engineers.

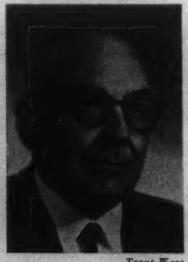
Albert Joseph Maslin (AM '42, M '47), manager, substation and tap changer engineering, Westinghouse Electric Corporation, Sharon, Pa., has been transferred to the grade of Fellow in the AIEE". . . for contributions to development of power transformers particularly for use with mercury arc rectifiers." Mr. Maslin was born near Calumet, Mich., on October 30, 1899. He received the B.S. degree in E.E. from the University of Michigan in 1922, and has done graduate work at the University of Pittsburgh. After graduation, he joined the Westinghouse Electric Corporation on the graduate student program. This was followed by work with the Products Protection Corporation, New Haven, Conn. In 1929, he rejoined Westinghouse at Sharon, Pa., as design engineer. His activity during the next 18 years embraced the design and theoretical investigation of load tap changers, transformers, and mercury arc rectifier apparatus and circuits. In 1947, he was appointed advisory engineer, and assigned to the staff of the engineering manager. Three years later he was named assistant to the engineering manager. In 1951 he became manager of general engineering, and in 1958 he was named to his present position. Mr. Maslin is a member of Tau Beta Pi, Sigma Xi, and has served on the AIEE Electronic Power Converters Committee (1947-51), Award of Institute Prizes Committee (1951-54), and Electrical Insulation Committee (1957-59).

Martin Hager McGrath, vice-president and chief engineer, General Cable Corporation, Perth Amboy, N.J., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to progressive development of high-voltage power cables particularly the pipe-enclosed gas pressure type." Mr McGrath was born in Pittsburgh, Pa., on September 16, 1902. After graduation in 1924 from Carnegie Institute of Technology with a B.S.E.E. degree, he was employed as assistant to the development engineer by the Standard Underground Cable Company, one of the antecedent companies of General Cable Corporation. During the last 35 years, he has, successively, held the positions of assistant to the chief engineer, high-voltage power cable engineer, assistant chief engineer, chief engineer, and, since 1955, his present post of vice-president and chief engineer. During World War II, he served on a Bureau of Ships special technical committee for the development of magnetic minesweeping cable, and was awarded the Secretary of the Navy's Commendation certificate. Mr. McGrath is a member of the Insulated Power Cable Engineers Association, National Association of Corrosion Engineers, International Conference on Large Electric High Tension Systems, Societe Francaise des Electriciens, and the Associazione Elettrotecnica Italiana. He has served on the AIEE Insulated Conductors Committee (1951-59, chairman 1953-55), Wire Communications Systems Committee (1956-59), and Power Division Committee (1953-57).

Adolf H. Mergenthaler (M '37), chief design engineer, Southern Services, Inc., Birmingham, Ala., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to planning of economic power system generating capacity." Mr. Mergenthaler was born in Oftersheim, Heidelberg County, Germany, July 11, 1896. He studied at the German Naval Engineer School and at the German Karls-

Gordon Campbell Buzzell

M. G. Malti



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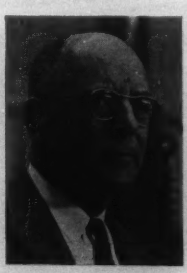
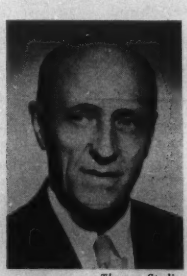
C. A. Martin



A. J. Maslin



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ruhe State College, from which he received an electrical engineering degree. In 1922-23, he worked as an engineer at the Siemens Schuckert Werke, Siemensstadt, Berlin. From there, he went to the New York Edison Company to work as an electrical draftsman, and then to the Dwight P. Robinson Company, New York, as an electrical designer. He was also an electrical designer for Thomas E. Murray, Inc., New York. In 1925-30, he was an engineer and power station engineer for the Dixie Construction Company, Birmingham, Ala., and in 1930-31, he was an engineer for Allied Engineers, Inc., Birmingham. He was an engineer for the Alabama Power Company, Birmingham, in 1931-39, and the principal electrical design engineer, Commonwealth & Southern Corporation, Birmingham, Ala., in 1939-49. This was followed, in 1949-55, with the post of principal electrical design engineer for Southern Services, Inc., Birmingham. In 1955, he was promoted to his present position. Mr. Mergenthaler is a registered professional engineer in the states of Alabama and Georgia. He has served on the AIEE Power Generation Committee (1951-59).

Joseph Casimir Michalowicz (AM '41, M '47), department head, electrical engineering department, Catholic University of America, Washington, D. C., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the education of electrical engineers." Mr. Michalowicz was born in Washington, D. C., on March 4, 1916. Following graduation with the B.E.E. degree from the Catholic University of America in 1940, he entered the student-trainee program of the Rural Electrification Administration (REA). The following year, he joined the Special Problems Section, Technical Standards Division, REA. In 1924, he joined the teaching staff of the department of electrical engineering, Catholic University, where he remained until his entry into the service of the U.S. Navy in 1944. After his officer indoctrination period, he was assigned to the Naval Research Laboratories in Anacostia, D. C., as an airborne-radio research officer. In 1946, he resumed his teaching career at Catholic University, where he has been head of the department of electrical engineering since 1952. He received his M.E.E. degree from Catholic University in 1951. He is a registered professional engineer in the District of Columbia, and State of Maryland, and has served as a consultant in engineering offices in the Washington area, which includes the American Council on Education. He is a member of the American Society for Engineering Education, and Sigma Xi. He has served on the AIEE Education Committee (1957-58).

William Henry Radford (AM '33, M '48), associate director, Lincoln Laboratory, Massachusetts Institute of Technology (MIT), Lincoln, Mass., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to national defense through education and communications." Mr. Radford was born in Philadelphia, Pa., May 20, 1909. He received the B.S. degree in E.E. from Drexel Institute of Technology in 1931, and the M.S. degree in electrical engineering from MIT in 1932. In 1957, he received an honorary doctorate degree from Drexel Institute. He was a research assistant in electrical engineering at MIT in 1932-39, and for the next 12 years was, successively, instructor, assistant professor, and associate professor. From 1951 to the present, he has been professor of electrical communications. In 1940-44, he was a consultant to the National Defense Research Committee. He was associate director of the MIT Radar School in 1944-47, staff member of the MIT Research Laboratory of Electronics in 1946-50, and group leader of the classified program of defense research in MIT Research Laboratory of Electronics in 1950-52. He joined the Lincoln Laboratory in 1952 as division head, and was promoted to associate director in 1957. Prof. Radford is a fellow of the Institute of Radio Engineers and of the American Association for the Advancement of Science. He is a member of the American Society for Engineering Education, Sigma Xi, Tau Beta Pi, and Eta Kappa Nu. He is also a member of the U.S. Air Force Scientific Advisory Board, and the Signal Corps Research and Development Advisory Council. He is a registered professional engineer of the commonwealth of Massachusetts.

Philip Ryan (AM '22, M '30), president, Cutler-Hammer, Inc., Milwaukee, Wis., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to creation and production of electrical controls." Mr. Ryan was born in Anaconda, Mont. He received the B.M.E. degree from Cornell University in 1920. Prior to this, he had worked for the Anaconda Copper Mining Company, Montana Power Company, and the U.S. Government as assistant assayer. Following his graduation from Cornell, he joined Cutler-Hammer, Inc., as a student engineer, and then was assigned to the Application Engineering Department. Some 10 years later he became purchasing agent of the company, and head of the manufacturing department. In 1951, Mr. Ryan took charge of development engineering, and at the same time became executive vice-president. In 1956, he became president of the company. He is a member of Tau Beta Pi, and Eta Kappa Nu.

Herbert Douglass Short (M '48), chief engineer, high-voltage engineering department, Canada Wire & Cable Company, Ltd., Toronto, Ont., Canada, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design and installation of high-voltage power cables of large capacity." Mr. Short was born November 25, 1909, in Thetford Mines, Que., Canada. He received a B.S. degree in E.E. in 1933 from Queen's University. While at college, he worked summers, in 1931-32, for the Ontario Department of Highways. In 1933-34, he was employed by the RCA Victor Company, radio engineering department, Montreal, and in 1934-36, for Sparton of Canada Ltd., London, Ont. In 1936-37, he worked for Roger Radio Tubes Ltd., Toronto, Ont., on the development of high-frequency oscillatory circuits. From 1937 to the present, he has been employed by the Canada Wire & Cable Company, Ltd. He was employed as an electrical engineer in 1937, where he has worked, successively, as electrical engineer, development engi-

H. D. Short

neer, assistant chief engineer, and, since 1952, chief engineer of the high-voltage engineering department. Mr. Short is a member of the Conference on Electrical Insulation of the National Research Council, the International Conference on Large Electric Systems (CIGRE) Study Committee on High Tension Insulated Cables, and the CIGRE Study Subcommittee on Filling Compounds. He has served on the AIEE Insulated Conductors Committee (1948-59).

W. A. Sumner

William Andross Sumner (AM '38, M '48), advisory engineer, long range development for distribution transformer department, Westinghouse Electric Corporation, Sharon, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to design of self-protective distribution transformers and to use of grain-oriented sheet steel transformer cores." Mr. Sumner was born in Rockville, Conn., January 21, 1896. He was graduated cum laude from Sheffield Scientific School, Yale University, with the Ph.B. degree in electrical engineering, and he did graduate study in electrical engineering at Yale in 1917-18. After a period of service in the U. S. Signal Corps, he joined the Westinghouse Electric Corporation as a graduate student. After 3 months of shop assignments and another 3 months in engineering school, he entered the transformer engineering department. For the next 10 years, he was engaged in the design of oil-insulated distribution, instrument, radio, and special transformers. In 1930-40, he served as section engineer, in charge of oil-insulated distribution developments. In 1940, he was made engineering manager of the entire Distribution Division. When departmentalization was established in 1955, he was made assistant engineering manager of this enlarged department. He is a registered professional engineer in the state of Pennsylvania. He is a member of Sigma Xi, and has served on the AIEE Protective Devices Committee (1956-59).

Kimball L. Wheeler (AM '30, M '40), manager, plant and substation engineering department, Cleveland Electric Illuminating Company, Cleveland, Ohio, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the development of a large power system and the rehabilitation of power systems in Korea." Mr. Wheeler was born July 23, 1904, in Ashtabula, Ohio. He received B.S. and M.S. degrees in E.E in 1928 from the Massachusetts Institute of Technology. After graduation, he was employed at Stone and Webster, Inc., as a student engineer, and was later assigned to the Blackstone Valley Gas and Electric Company where he became assistant substation foreman. In 1933, he joined the Cleveland Electric Illuminating Company as substation operator. He was promoted in 1937 to junior and then senior engineer in the Substation Division of the electrical engineering department. In 1943, he joined the U. S. Army Signal Corps as a first lieutenant, and was later assigned to the Signal Corps Standards Agency as officer-in-charge of the Electromechanical Section. In 1944, he was assigned as engineering officer of a Philippine Civil Affairs unit stationed in Manila. After V-J day, he was assigned as engineering officer to a military government company, and transferred to Korea where he became enemy property custodian of Cholla Pucto province. In 1946, with the rank of major, he was made chief, Electric Section, Department of Commerce, responsible for the operation and engineering of all utilities and electrical manufacturing in the American zone of Korea. Returning to the Cleveland Electric Illuminating Company in 1946, he became a senior engineer, and, in 1951, supervising engineer of the Substation Engineering Section. In 1953, he was promoted to manager of the plant and substation engineering department. He is a registered professional engineer in Ohio. He has served on the AIEE Switchgear Committee (1947-48), Substations Committee (1948-56, chairman 1952-54), Power Division Committee (1952-54), and Sections Committee (1956-58).

Lou Moore Photographer

K. L. Wheeler

AIEE PERSONALITIES

W. H. Chase

W. H. Chase (M' 41 F' 51), vice-president of the Ohio Bell Telephone Company, Cleveland, Ohio, became vice-president of the newly formed District No. 14 (Allegheny-Ohio Valley) of the AIEE on August 1, 1959. The District is comprised of Eastern Ohio, Western Pennsylvania, and West Virginia. He had served as vice-president of District No. 11 since August 1958. A veteran of 38 years in the telephone business, Mr. Chase became chief engineer of the Ohio Bell Company in 1945, assistant vice-president in 1950, and vice-president in 1954. In his native city of Cleveland he is well known, not only for his prominence in engineering circles but also as an active leader and worker in civic and welfare enterprises. He is currently chairman of the Greater Cleveland Chapter of the American Red Cross, a trustee of the Cleveland Hearing and Speech Center, chairman of Marymount Hospital's Civic Advisory Board, chairman of the River and Harbor Committee of the Chamber of Commerce, member of the Cleveland Heights Planning Commission, past president of the Cleveland Technical Societies Council, past president (two terms) of the Cleveland Engineering Society. He was the prime mover in the financing and construction of Cleveland's new Engineering and Scientific Center. He was nominated vice-president of AIEE District No. 11 in October 1957 and elected the following August. Born in Cleveland in 1898, Mr. Chase attended Hiram College and Case Institute before receiving his degree from Harvard School of Engineering. In the AIEE, he has served for the last 15 years as member and chairman of numerous committees. He has served on the AIEE Lamme Medal Committee (1956-59), Management Committee (1954-58), and Administration Committee (1957-58).

A. W. Rauth (AM '28, F '48), general meter and laboratory superintendent of the Consumers Power Company, Jackson, Mich., was elected to complete the term of W. H. Chase as vice-president from AIEE District No. 11. He was born in Warrick County, Ind., and graduated from Purdue University in 1923 with a B.S. degree and an E.E. degree in 1929. During summer vacations from Purdue, he worked in the coal mines of Southern Indiana. After graduating from college, he spent 26 months with the Westinghouse Electric Corporation, the last 14 months of which were spent in relay and circuit breaker application work. He taught school at Rose Polytech in 1925-26 and went to Jackson, Mich., in July 1926 where he worked with Allied Engineers and its predecessors until 1930 when he joined the Consumers Power Company. Mr.

A. W. Rauth

Rauth is a registered professional engineer. He is presently chairman of the Meter and Service Committee of the Association of Edison Illuminating Companies and is a past chairman of the Metering Subcommittee of the American Gas Association. He is chairman of a number of task committees to rewrite metermen's handbooks and standards for both the electric and the gas metering art. He is author of patents on the automatic testing of electric and gas meters. He is active in the International Association of Electrical Inspectors and is a member of the Indiana Academy of Science. He is a past chairman of the Michigan Section of AIEE and has been very active in the activities of the Section since 1935. He has been active in civic, church, fraternal, and luncheon club activities. He has served on the AIEE Indicating and Integrating Instruments Committee (1957-59), and Technical Program Committee (1944-45).

G. R. Archer (AM '54) has been named chief engineer, Electronic Controls Section, The Budd Company. He was first associated with the company in 1952 as a stress analyst in the Weapons Division. In 1955, he was appointed a project engineer, and has worked in the Manufacturing Methods Research and the Airframe Research Laboratories of the company.

C. F. Boehnlein (AM '55) has been assigned as industrial manager, Richmond, Va., branch office, Minneapolis-Honeywell Regulator Company's Mid-Atlantic region. Mr. Boehnlein joined Honeywell's Brown Instruments Division in 1945 and has been a branch sales engineer since 1950.

P. F. Boggess (AM '48) has been appointed chief engineer of the power systems department, Hallamore Electronics Division, The Siegler Corporation. In his new post, Mr. Boggess is directly responsible for the design and development of electric power systems, with particular emphasis on systems using the Hallamore constant frequency a-c alternator. He joined Hallamore after 12 years with the Westinghouse Electric Corporation, where he was manager of the systems and analytical department.

D. A. Bourne (AM '49) has been advanced to development engineer in the General Development Area of the International Business Machines Corporation (IBM) Advanced Systems Development Division at Poughkeepsie, N. Y. In his new position, Mr. Bourne is responsible for the design and development of advanced circuit design involving analog-to-digital conversion equipment and other circuit building blocks, which can be used to further the development of new systems. Mr. Bourne joined IBM in 1957 as a staff engineer in the Kingston Military Products Division's Air Traffic Control.

F. U. Bower (AM '49), construction manager of the nuclear reactor being built by Atomics International as a part of the atomic power plant at Piqua, Ohio, began his assignment in Piqua on June 29. Atomics International is a division of North American Aviation, Inc. Before joining Atomics International in 1956, Mr. Bower was an electrical engineer and construction inspector for the City of Los Angeles, Calif.

M. M. Brandon (AM' 28, F '44) was elected president of Underwriters' Laboratories, Inc., at its annual meeting in April. He joined the staff of Underwriters' Laboratories in September 1921 as assistant engineer in the Gases and Oils Department. He has worked successively in Underwriters' Laboratories as factory inspector, service engineer, chief inspector, associate electrical engineer, vice-president and electrical engineer, and vice-president in charge of eastern operations. Mr. Brandon has served on the following AIEE Committees: Domestic and Commercial Applications (1943-51, chairman 1947-49); Safety (1944, 1948-59); Standards (1944-59, chairman 1952-59); Technical Program (1947-52, chairman 1951-52); Insulated Conductors (1947-48); General Applications Division (1947-49); Planning and Co-ordination (1951-52); and Technical Operations (1952-54, 1958-59).

R. N. Brown (AM '46), vice-president and assistant general manager, Kearfott Company, Inc., Clifton, N. J., a subsidiary of General Precision Equipment Corp., has been elected a director of the company. Mr. Brown is also manager of the company's newly established avionics operations group.

R. J. Cantwell (AM '52, M '59) has been appointed senior engineer, systems studies, advanced systems research, International Business Machines Corporation, Owego, N. Y. In his present assignment, Mr. Cantwell manages a study, surveillance, and simulation program in co-operation with the Air Force on advanced guidance systems.

R. L. Casselberry (AM '50), manager of product planning and marketing research for General Electric two-way radio for the past 5 years, has been named acting manager of the technical products operation of General Electric's communication products department, with offices at Electronics Park, Syracuse, N. Y.

W. L. Cisler (M '35, F '47), president of the Detroit Edison Company, has been named to lead the 50,000-member American Society of Mechanical Engineers. Nominees for vice-president include: **D. E. Marlow** (M '55), dean of the School of Engineering and Architecture, Catholic University of America, Washington, D. C., and **H. N. Muller, Jr.** (AM '37, F '49), vice-president of Canadian Westinghouse Company, Ltd., Hamilton, Ont., Canada. Mr. Cisler is a member of the AIEE Edison Medal Committee (1956-61), and has served on the following Committees: Power Generation (1935-43, chairman 1940-42); Technical Program (1940-42); Standards (1941-42); Management (1947-54, chairman 1948-49); and Professional Group Co-ordinating (1948-49). Mr. Muller has served on several Institute Committees: AIEE Power Generation (1944-46, 1957-59); Members-for-Life Fund (1954-59); Membership (1948-50); Education (1947-53, chairman 1950-52); Award of Institute Prizes (1948-49); Professional Division Advisory (1948-52); Student Branches (1948-54, chairman 1948-49); Charles LeGeyt Fortescue Fellowship (1947-50, chairman 1949-50), and Publications (1952-58).

W. L. Cisler (M '35, F '47), president of the Detroit Edison Company, delivered the principal commencement address June 13 at the 87th annual commencement exercises of Stevens Institute of Technology. He was awarded an honorary doctor of engineering degree by Dr. W. H. Taylor, chairman of the Stevens board of trustees, for his contributions to atomic energy development as the leader of the 13th largest utility company in the country. A former executive secretary of the Atomic Energy Commission Industrial Advisory Group, he is responsible for Detroit Edison's work with the Atomic Power Development Associates, Inc., and the Power Reactor Development Company. An honorary doctor of engineering degree was awarded also to **R. C. Roe** (AM '18, F '33, Member for Life), president of Burns and Roe, Inc., for his contributions to the design and construction of power plants. He has led the corporation in power plant work for the Jersey Central Power and Light Company; the Atomic Energy plant of the Duquesne Light and Power Company at Shippingport, Pa., and the Board of Water and Electric Light Commissioners in Lansing, Mich. He has supervised work on large scale laboratories for testing gas turbines, and the program for detecting hostile aircraft. **Fulton Cutting** (M '17, F '55, Member for Life), assistant to the president and vice-chairman of the Stevens board of trustees, received an honorary doctor of science degree for his contributions in the field of radio transmitters.

Top management appointments were announced in July by the Raytheon Company. **D. D. Coffin** (AM '25), former vice-president and manager of the Missile Systems Division, was elected group vice-president—government. **E. N. Kather** (AM '41) was promoted from assistant manager to manager of the Microwave and Power Tube Division. Mr. Coffin, honored in June for 25 years of leadership in the company, has helped build the Missile Systems Division into the company's largest segment. This division is prime contractor for both the Army's surface-to-air Sparrow III missiles. Mr. Kather, a 16-year veteran with Raytheon, joined the company in

1943 as an engineer in the microwave development laboratory.

K. C. Cummings (AM '48) has been appointed manager of engineering, Minneapolis-Honeywell's Beltsville, Md., Division. He had been associate director of research of the company's Aeronautical Division, and now is responsible for the design and development of magnetic tape systems and components for the instrumentation and data-handling fields.

W. H. Davis (AM '50) has been appointed assistant manager, Norwood (Ohio) electrical department, Allis-Chalmers Manufacturing Company. Mr. Davis had been manager of product sales, Norwood electrical department, since 1958. **R. G. Marsh** (AM '53) has been named supervisor, a-c variable speed sales, electrical department. Mr. Marsh had been an application engineer in industrial and marine sales at the Norwood Works.

Bern Dibner (AM '23, F '42, Member for Life), president of Burndy Corporation, Norwalk, Conn., was awarded an honorary degree of doctor of engineering by the Polytechnic Institute of Brooklyn at its 104th annual commencement exercises. Dr. Ernst Weber, president of the Polytechnic Institute, presented the doctorate to Dr. Dibner, who heads the electrical connector manufacturing corporation and is founder and director of the Burndy Library, a nonprofit institution devoted to the history of science and technology, with emphasis on electricity.

R. J. Dineen (AM '57) has been appointed product sales manager, electrical department, Norwood (Ohio) Works of the Allis-Chalmers Manufacturing Company. Mr. Dineen had been manager for general products division sales in the Allis-Chalmers central region.

R. F. Dirkes (M '48), formerly assistant vice-president of Facsimile and Private Wire Services, has been promoted to general manager of Western Union's newly created Government and Contract Sales Division. Establishment of the new division was designed to keep pace with the continuing rapid growth in the use of private wire services by military and other Government users.

H. R. Drew (AM '49), of Fort Worth, Texas, has been elected executive vice-president of the Texas Atomic Energy Foundation, which was organized in April 1957 by 11 investor-owned electric utility companies operating in Texas for the purpose of unifying their individual efforts in the field of nuclear energy.

J. H. DuBois (M '54) has purchased Tech Art Plastics Company, Morristown, N. J. Mr. DuBois is proprietor of his own plastics consulting firm and is a director of National Beryllia Corporation. He will become chairman of the board of Tech Art.

A. B. Du Mont (F '43) was re-elected a director of Allen B. Du Mont Laboratories, Inc., June 24 at the annual meeting of shareholders.

J. R. Eastman (AM '51), chief engineer, Sterling Electric Motors, Inc., Los Angeles, Calif., has been elected vice-president, engineering, of the firm.

L. W. Eighmy (AM '36), of the Kerite Company, New York, N. Y., has had his title changed to technical assistant to president. **J. H. Cowan** (AM '46) has had his title changed to Philadelphia district manager.

G. B. Entrekin (AM '42), manager of the Burlington (Iowa) plant of International Resistance Company, has been named vice-president and general manager of Communication Accessories Company, Lee's Summit, Mo., subsidiary of Collins Radio Company.

William Fondiller (M '15, F '26) has been elected to the board of directors of Mycalex Corporation of America. For the last 2½ years he had been serving as consultant to the Mycalex Corporation and its affiliated companies. Dr. Fondiller was associated with the Western Electric Company and the Bell Telephone Laboratories for more than 40 years before he retired as assistant vice-president. He was a member of the AIEE Electrophysics Committee (1922-24).

C. H. Grace (AM '52, M '59) has been appointed manager of systems integration and control at the Owego, N. Y., facility of International Business Machines Corporation (IBM). In this assignment, Mr. Grace will be responsible for the establishment of performance requirements for electronic equipment, systems engineering, and program co-ordination. He joined IBM at Endicott, N. Y., in July 1951 as a design engineer. Since July 1958, he had been manager of systems co-ordination and planning at IBM Endicott. He has served on the AIEE Basic Sciences Committee (1957-59).

T. K. Greenlee (AM '47), formerly in charge of electromechanical activities within the Grand Rapids Division of Lear, Inc., has been named general manager of the Electro-Mechanical Division, one of the two separate general operating divisions into which the Grand Rapids Division has been reorganized.

R. C. Hamilton (AM '55), engineering specialist, electromechanical development, California Institute of Technology Jet Propulsion Laboratory, has been appointed to serve on the Electrical Power Plant Systems Committee, a Research Advisory Committee of the National Aeronautics and Space Administration.

G. W. Hanafee, Jr. (AM '51) has been appointed manager of the Indianapolis, Ind., district, Allis-Chalmers Manufacturing Company. He had been a sales representative in the Indianapolis district since 1952.

B. C. Harmon (AM '50) has been named manager of the Akron, Ohio, Branch Office, Clark Controller Company. Mr. Harmon replaces **W. J. Backus** (AM '47), who has been promoted to manager of the firm's Cincinnati, Ohio, District Office.

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P. B. Harwood (M '36, F '42), who was formerly vice-president in charge of engineering, Cutler-Hammer Inc., has been appointed senior vice-president. Mr. Harwood plans to retire during the latter part of 1959 after 42 years of service. He will be a consultant to the electrical corporation's engineering department and to its management prior to retirement. He served on the AIEE Standards Committee (1939-41) and Marine Transportation Committee (1941-45).

M. D. Henry (AM '51), of the Alabama Power Company, has joined Anderson Electric Corporation, Birmingham, Ala., as sales application engineer for the Distribution Division.

G. E. Hertig (AM '51, M '58), who was formerly substation application engineer, Greensburg Division, I-T-E Circuit Breaker Company, Greensburg, Pa., has been appointed consulting engineer, EHV systems. He has been a member of the AIEE Substations Committee (1958-59).

Thomas Hollingsworth (AM '49, M '59) has been appointed general sales manager, Hubbard and Company. He will operate out of their Chicago, Ill., executive offices. Mr. Hollingsworth was most recently director of marketing for Electrical Engineers Equipment Company, a Hubbard subsidiary.

J. H. Howard (AM '41), former manager of the Research and Development Division, Burroughs Corporation, is now manager, Paoli Laboratory, Paoli, Pa. He will be responsible for line technical management of research and development programs assigned to the Paoli Laboratory with prime responsibility in the commercial product areas.

R. J. Keeler (AM '56), has been named manager, Rumsey Electric Company Industrial Equipment Department. The late William C. Dages held the position before Mr. Keeler, who will also continue in his position as sales manager of the department.

D. Y. Keim (AM '37) has been appointed chief engineer, military products of the Electronics Division, Stromberg-Carlson, a division of General Dynamics Corporation. Mr. Keim previously served as engineering department head, microwave and electronic equipment, Sperry Gyroscope Company.

W. C. Knopf, Jr. (AM '46) has been named technical director of the USI Technical Center, Pompano Beach, Fla., research and development division of U. S. Industries, Inc. (USI). Prior to his new appointment, Dr. Knopf had been assistant director of research at International Minerals and Chemical Corporation since 1954.

K. S. Koon (AM '41, M '56) has been appointed senior engineer, Environmental Evaluation, Owego, N.Y., facility of In-

ternational Business Machines Corporation (IBM). In this assignment, Mr. Koon is responsible for the management of the environmental testing facilities and operations at IBM Owego. Mr. Koon became associated with IBM at Endicott, N.Y., in April 1934. He has been serving on the AIEE Electronics Committee (1949-59).

Dixon Lewis (AM '30, M '38), who has been assistant manager of electric conductor sales for the Aluminum Company of America (Alcoa) since 1953, has been named product manager of conduit for Rome Cable Corporation, which recently became an Alcoa subsidiary. Alcoa has transferred responsibility for aluminum conduit sales to Rome Cable. Mr. Lewis is a member of the AIEE 75th Anniversary Committee, and has served on the following committees: Transmission and Distribution (1952-58); Sections (1952-58, chairman 1955-57); Public Relations (1955-57); Planning and Co-ordination (1955-56, 1958-59); Administration Department (1956-57) and Admission and Advancement Department (1957-58).

R. G. Lockett (M '37), western regional sales manager, I-T-E Circuit Breaker Company, Philadelphia, Pa., has retired after 22 years service. He is succeeded by **R. G. Petersen** (AM '54), who recently returned to I-T-E after 6 months Government service on loan from the company.

H. A. Maxfield (AM '21, Member for Life), head of the department of electrical engineering at Norwich University, Northfield, Vt., has retired from active service. Prof. Maxfield joined the Norwich faculty in 1952. He served on the AIEE General Power Applications Committee (1930, 1932-36).

D. B. McKey (AM '45) has been appointed staff technical consultant of Milgo Electronic Corporation, Miami, Fla. Prior to joining Milgo, he was manager of the Range Design and Operation Section of Philco Corporation's Western Development Laboratories.

Robert Paxton (AM '26, F '48), president of the General Electric Company since April 23, 1958, has over-all responsibility for managing the company's operating components. In his new position, he is the successor to R. J. Cordiner as chief executive of the company and chairman of the Board of Directors.

R. L. Reese (AM '55), chief engineer, pole line hardware, Hubbard and Company, Chicago, Ill., has been elevated to the position of manager, product development.

N. R. Rimboi (AM '58), director of Fenn College's Technical Institute, has been elected chairman of the Ohio Section of the American Society for Engineering Education.

R. L. Sell (AM '50), chief engineer, Audio Development Company, Minneapolis, Minn., will be in charge of the sales and engineering activities of the new Magnetic Components Division formed at Telex, Inc., St. Paul, Minn.

OBITUARIES

William B. Blanton (AM '57), assistant to the vice-president in charge of planning, and director of plant and systems, Western Union Telegraph Company, New York, N. Y., died recently at the age of 58. A graduate of Virginia Polytechnic Institute in 1922, Mr. Blanton had been associated with the telegraph company for 37 years where he worked on the development and engineering of switching circuits and equipment. His birthplace was in Newport News, Va. The first winner of the annual d'Humy Award, in 1956, given in recognition of contributions to the art of telegraphy, Mr. Blanton, since 1949, had been in charge of all new switching systems used by Western Union or leased to private industry and the Armed Services. He was a member of the AIEE Data Communication Committee (1957-59).

Thorsten A. Fjellstedt, Sr. (AM '50), manager of power switching engineering, Line Material Industries, Milwaukee, Wis., died recently at the age of 61. A native of Sweden, Mr. Fjellstedt came to the United States at an early age. He studied mechanical engineering at Lewis Institute, Chicago, Ill. Mr. Fjellstedt, who was noted for his inventions of high-tension switching equipment, joined Line Material in 1951. Prior to this, he did extensive work in design, development, and production for an electrical manufacturer in Chicago.

Lanier Greer (M '42, F '53), chief engineer of d-c machine design and electrical insulation, Reliance Electric and Engineering Company, Cleveland, Ohio, died recently. He was born November 27, 1901, in Tyler, Texas. He received his B.S. degree in E.E. from Texas Agricultural and Mechanical College in 1924, and was engaged in graduate work there for the next year. He served on the AIEE Rotating Machinery Committee (1951-59), Mining Industry Committee (1958-59), Mining and Metal Industry Committee (1948-58), and Dielectrics Committee (1955-58).

Roy Emanuel Kistler (AM '17, M '30, F '46, Member for Life), transmission and protection engineer, Pacific Telephone and Telegraph Company, Seattle, Wash., died recently. He was born May 15, 1893, in Moscow, Idaho, and received the B.A. degree in E.E. from Stanford University in 1915. He went to work for Pacific Telephone and Telegraph Company in 1919 as an inductive interference engineer in San Francisco, Calif. In 1926, he became protection engineer for the company in Seattle, and, in 1933, he was promoted to transmission and protection engineer. He was an AIEE director in 1953-58, and served on the AIEE Constitution and Bylaws Committee (1957-59, chairman 1957-58); Sections Committee (1946, 1948-58); Planning and Co-ordination Committee (1954-56); Publication Committee (1954-56); and Registration of Engineers Committee (1947-49).

Herman Charles Koenig (AM '18, M '30, F '51, Member for Life), manager of the Electrical Laboratory, and member of the board of directors, Electrical Testing Laboratories, Inc., New York, N. Y. died recently. He was born November 28, 1893, in Hoboken, N. J., and graduated magna cum laude in 1915 from the Cooper Union Institute of Electrical Engineering. He entered the employ of Electrical Testing Laboratories upon graduation, and, while there, taught physics and electrical measurements in the Cooper Union Night School of Engineering for 35 years, until 1951. He served on the AIEE Instrumentation Division Committee (1956-59); Recording and Controlling Instrumentation Committee (1956-59); Indicating and Integrating Instruments Committee (1956-59); Standards Committee (1953-55, 1957-58); Instruments and Measurements Committee (1927-30, 1932-46, 1948, 1951-56, chairman 1936-39); Liaison Representative on Standards Committee (1951-53); and Technical Program (1936-39).

William Alfred Stein (AM '44, M '51), professor of the U. S. Naval Postgraduate School since 1951, died recently at the age of 37. He was born May 5, 1922, at Carmel, Calif. He received the B.S., M.S., and D.Sc. degrees from Washington University, and, after a few years on the faculty of Washington University, he joined the teaching staff of the naval school. His special field was feedback control systems about which he wrote several papers. Dr. Stein was a member of Sigma Xi.

Hugo William Wahlquist (M '36), corrosion engineering consultant for Ebasco Services, Inc., died recently at the age of 63. He was born in Duluth, Minn., and received a B.S. degree in E.E. at the University of Minnesota. Mr. Wahlquist was a pioneer in the use of various methods and procedures to overcome the effects of corrosion on such structures as pipelines, underground cables, piers, ships, electric generating plants, large storage tanks, and water intake facilities. He served on the AIEE Chemical Industry Committee (1947-59), and was AIEE representative on the National Association of Corrosion Engineers, Intersociety Committee on Corrosion.

Christopher Rowland Webster (AM '48, M '58), area sales manager, Westinghouse Electric Corporation, Raleigh, N. C., died recently. He was born February 1, 1918, in Baltimore, Md. He graduated in 1939 from Duke University with a B.S. degree in E.E. After an assignment on the Westinghouse Student Course in East Pittsburgh, Pa., he joined the Westinghouse Electric Corporation, where he had been employed continuously, except for service in the U.S. Navy during World War II when he attained the rank of lieutenant commander. He had served the AIEE as chairman of Student Branch at Duke, chairman of the Eastern North Carolina Subsection, and secretary-treasurer of the North Carolina Section. He was also a member of the North Carolina Society of Engineers, and past president of the Duke University Engineers Alumni Association.

OF CURRENT INTEREST

▲ *These "parametric amplifiers," called "Paramps" by their developers, Hughes Aircraft Company scientists, are displayed by C. W. Curtis, manager of the company's microwave engineering laboratories. The devices can increase microwave signals picked up by air traffic control radar antennas in such a way as to double the distance at which multiple planes traveling at jet speeds can be detected.*

Microwave Device Seen as Boon to Jet-Age Traffic Control

MANY MAJOR PROBLEMS of jet-age air traffic control can be solved by a simple addition to existing ground and aircraft radar systems, according to scientists of Hughes Aircraft Company who recently announced the development of a new device "capable of increasing radar range as much as 100%."

A tiny "parametric amplifier" displayed during a meeting at the Mayflower Hotel, Washington, D.C., was described by C. W. Curtis, manager of the company's microwave engineering department, as the result of 2 years' research and development in Hughes' Culver City, Calif., laboratories. It was described as inexpensive, easily maintained, and simple to incorporate in present equipment.

Dr. N. I. Hall, the company's vice-president–engineering, called the device "a major breakthrough in long-range detection and surveillance of multiple aircraft flying at jet speeds." He added that "the greater range is achieved by increasing the radar's power output by more than 10 times."

"Paramp," as the microwave device is called by the scientists who developed it, not only can extend the range of radar signals from airport systems and tracking stations, but also from civilian airliners. Thus, the crews will be able to detect turbulent weather at much greater distances.

Several different parametric amplifiers of the Paramp series were displayed and it was reported that Hughes has the scientific capability and physical facilities to produce all of them in quantity. A typical Paramp device is approximately 8 inches long, 6 inches high, and 1 inch wide.

Five Advantages Cited

Paramp boosts the microwave signals picked up by an antenna in such a way as to increase the sensitivity of the receiver remarkably. The net effect can be to double the distance at which targets can be detected by that radar.

Because the arrival of the jet age in civilian air traffic has posed new problems, such as greatly increased speed and higher fuel consumption, the Hughes parametric amplifier, added to existing air traffic control radar, provides five advantages:

1. The area of control by a single airport surveillance radar can be enlarged so that high-speed jets can be detected much earlier and farther away, thus, be programmed into the terminal more smoothly.

2. Greater sensitivity provided by Paramp at shorter range permits detection of such vague or previously undetectable targets as small business planes and small military jets. Such planes may fade on existing radar and it is frequently necessary to delay their landing to permit safe approach of large commercial liners.

3. Airport radar on high-density traffic lanes like New York–Miami and Chicago–New York would be able to maintain constant surveillance on all sizes and types of planes and improve take-offs and landings.

4. Installation of parametric amplifiers in way-station check point radars would provide increased coverage, requiring fewer stations and cutting costs.

5. Although jet airliners fly above the weather during most of a flight, they must contend with possible storms and turbulence on ascending and descending. Paramp-adapted radar would warn of weather disturbances much earlier and help pilots avoid them.

New Amplifier Reduces Noise

It was explained that existing amplifiers are never perfect, because in the process of amplifying a radar signal they add some noise to it. This noise sets a lower limit on the strength of signal that can be amplified effectively.

In vacuum tube amplifiers, for example, noise comes principally from the electron stream in the vacuum which is boiled out of the hot cathode of the tube. However, in the parametric amplifier there is no hot cathode or noisy electron stream; rather there is the ordered structure of a crystal of germanium or silicon.

The solid-state parametric amplifier contributes very little noise to the signal, giving it the capability of effectively amplifying much weaker signals or signals of more distant origin than conventional amplifiers.

The heart of Paramp is the "P-A" diode, a microscopic solid-state device developed by Hughes research laboratories. The Hughes Products Group's Newport Beach, Calif., plant is producing several hundred of the diodes weekly to meet current industrial requirements.

NO BIGGER than a grain of rice or a match head is this gold-bonded diode, the key unit of a "parametic amplifier" (itself the size of a house brick) announced recently by Hughes Aircraft Company scientists. The diode also has other important microwave applications such as switching and harmonic generation.

Insulation Vital in Steam Generating Plant Efficiency

STEAM GENERATING PLANTS for the manufacture of electricity are becoming increasingly efficient as power utility engineers continue to improve the design and construction of these new power stations. Proper and adequate use of structurally strong high-temperature insulations contribute materially to the efficiency of these stations as they reduce heat loss and thereby conserve fuel.

An example of this use of insulation is seen at the Clinch River Plant of the Appalachian Power Company, recently placed in service in Carbo, Va.

One of the most efficient facilities of its type in the world, the $60 million Clinch River Plant is a part of one of the largest electric systems in the nation, the American Electric Power Company of which Appalachian is an operating company. American Electric Power has long been known for the operating efficiency of its plants. Last year, its average price per kilowatt-hour sold to residential customers was 2.27¢ compared with the national average of 2.53¢.

Kaylo pipe and block insulation was selected to reduce heat loss at the plant, which has a capacity of 450,000 kw (sufficent to supply a city the size of New Orleans, La.). More than 71,000 lineal feet of this pipe covering and 731,000 board feet of block high-temperature insulations were applied, ranging from thicknesses of 1 to 4 or 5 inches. This insulation is manufactured by Owens-Corning Fiberglas Corporation, Berlin, N. J.

This hydrous calcium silicate product, effective to 1,800 degrees, was introduced in 1943 after 5 years of development, and since then it has gained wide acceptance in the power and process industries.

The power plant's location on a 105-acre site near Carbo has several advantages which contribute to efficient operation. It is situated in the middle of an extensive field of economically-mined coal and it is able to utilize existing transmission lines to feed the bulk of its power to major load centers.

The plant's two 225,000-kw turbine-generators are capable of providing electrical service to 650,000 average homes. These generators produce electricity at 15,500 volts, which is stepped up by transformers to 138,000 volts for transmission.

Coal is ground to face-powder fineness by pulverizers and then is fed into the two

Photos courtesy Owens-Corning Fiberglas Corporation

KAYLO PIPE INSULATION is applied in double layers (above, *left*) to the main steam and reheat steam lines at the Clinch River steam-electric generating plant of the Appalachian Power Company at Carbo, Va. Sectional coverings were sawed into miters in the shop to fit the curvature of the pipe. Joints were broken and cemented on both layers. Finish for the bends consists of mastic applied over a layer of glass cloth. Kaylo block and pipe insulations were applied during construction of the station for the purpose of reducing heat loss and thereby conserving fuel. The plant's two boilers, each 10 stories high, produce steam at a pressure of 2,000 pounds per square inch and at a temperature of 1,050 F. *Above, right:* The valve on the condensate line is covered with Kaylo pipe covering, field cut to fit the valve and fastened with copper wire. The finish coat was glass cloth and mastic, troweled to a smooth finish. A total of 71,000 lineal feet of Kaylo pipe covering and 731,000 board feet of Kaylo block was installed at the station. Appalachian is one of six operating companies of American Electric Power Company which serves a seven-state area from the North Carolina border to Michigan.

outdoor-type boilers. These boilers, each 10 stories high, produce steam at a pressure of 2,000 pounds per square inch at a temperature of 1,050 F.

As power flows from the generators, it is fed through the switchyard into three 138,000-volt transmission lines which link the plant to Appalachian's far-reaching transmission system.

Four cooling towers, which are constructed of treated redwood, add a unique appearance to the plant. Each tower is 61 feet high and 281 feet long. Each with ten 22-foot fans, the towers can cool water a maximum of 19 degrees at a rate of 55,000 gallons per minute.

Appalachian has five other steam plants located at Graham Station, Glasgow, Cabin Creek, and Logan, all in West Virginia, and at Glen Lyn, Va.

Other operating companies of American Electric Power are: Indiana & Michigan Electric Company, Kentucky Power Company, Kingsport Utilities, Inc., Ohio Power Company, and Wheeling Electric Company.

Progress Made in Development of Practical Tunnel Diode Devices

THE TUNNEL DIODE, little over a year old, is both better understood and closer to commercial application as a result of an intensive research program, according to Dr. Guy Suits, General Electric Company (GE) vice-president and director of research.

The tunnel diode, first reported in 1958 by Japanese scientist Leo Esaki, is first cousin to a transistor, but operates on a different principle and offers advantages that the transistor does not. Before long, it should find its way into high-speed computers, television sets, communication equipment, nuclear controls, satellites, and space vehicles, Dr. Suits predicted.

"Because we were convinced that the tunnel diode could lead to revolutionary changes in the electronics industry, we launched a concentrated research program on the subject," Dr. Suits said. "This has resulted in important new scientific understanding of the device, which has led to vastly improved tunnel diodes, as well as a number of significant improvements in the field of applications."

"Further advances in the design and application of tunnel diodes can be expected, and it is probable that transistors and other solid-state devices will also benefit from the new knowledge."

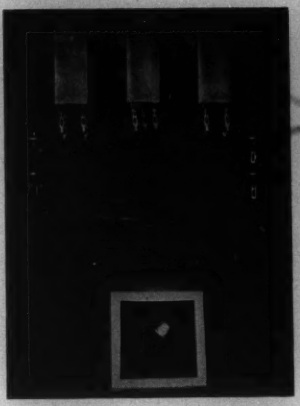
One of the most significant advances in scientific understanding of the device originated with some observations of mysterious "wiggles" in performance curves. These were first noted by Dr. Nick Holonyak, Jr., and Dr. Arnold Lesk of GE's Advanced Semiconductor Laboratory, in Syracuse, N. Y. A theory that successfully explained the puzzling effect was subsequently worked out at the GE Research Laboratory in Schenectady, N. Y., by Dr. J. J. Tiemann, Dr. R. N. Hall, and Dr. Henry Ehrenreich.

The tunnel diode takes its name from the physical phenomenon that makes it possible: "quantum-mechanical tunneling." The term is used to describe the manner in which the electric charges move through the device. Such motion takes place with the speed of light in contrast to the relatively slow motion of electric charge carriers in transistors.

The high speeds at which electric charges travel in the tunnel diode make it possible for the device to operate at extremely high frequencies. Oscillation frequencies higher than 2,000 mc have already been obtained, matching advanced transistor performance, and frequencies of more than 10,000 mc are expected.

The device's high-speed response also suggests applications in computers. When used as switches, tunnel diodes have functioned in a fraction of a millimicrosecond —from 10 to 100 times as fast as the fastest transistor.

The device also resists the damaging



TUNNEL DIODE *(in can, at bottom of photo)* **can perform simultaneously the following functions that are necessary in an FM receiver: amplification, oscillation, conversion, limiting, detection, and automatic frequency control. If an FM receiver were rebuilt using a tunnel diode, all of the conventional components shown in the photo could be omitted, although with some sacrifices in performance. Such performance limitations reflect the present state of the art and not the inherent capabilities of the tunnel diode.**

A COMPLETE tunnel diode transmitter is compared in size wtih a 50-cent piece. The transmitter consists of one variable and two fixed ceramic capacitors, a coil that tunes to the operating frequency—which may be higher than one kilomegacycle per second—and the tunnel diode itself, located inside the "can" in the center of the device.

VEST-POCKET TRANSMITTER, making use of a tunnel diode, and with a range of approximately ½ mile, is demonstrated by GE Research Laboratory scientists. Dr. Guy Suits *(left)*, **GE vice-president and director of research, speaks into microphone; Dr. J. J. Tiemann** *(right)* **holds the FM transmitter. A receiver** *(foreground)* **picks up the signal.**

effects of nuclear radiation. Because it is less dependent on the structural perfection of its crystal than is the transistor, it is much less affected by the damage that radiation can do to such crystal structures. In this respect, it outranks transistors by more than 1,000 to 1. Semiconductors that have been used by GE scientists for making tunnel diodes include silicon, germanium, gallium arsenide, gallium antimonide, and indium antimonide.

The tunnel diode is smaller than a transistor and, because of a simpler structure, ultimately will be a small fraction of its present size. It also is little affected by environmental conditions. Silicon tunnel diodes work at temperatures as high as 650 F; conventional silicon diodes will not operate above 400 F.

As an electric circuit element, the tunnel diode exhibits a unique combination of electrical properties, including what is called a "negative resistance" over part of its operating voltage range. These characteristics allow it to be used in a wide variety of applications, such as an amplifier, a generator of r-f power, and a switching device. The simplicity of this device makes possible the development of "integrated circuits," in which entire circuits for some applications may be formed on a single semiconductor structure. It is superior to vacuum tubes and transistors for applications in low-noise amplifiers and mixers for high frequencies. Many parametric amplifier jobs, for example, could be performed more easily by tunnel diodes.

New Distribution System for a City 300 Years Old

Now celebrating its 300th Anniversary is Ciudad Juarez, in the State of Chihuahua, Mexico, located across the Rio Grande from El Paso, Texas. Much effort has gone into equipping this growing city with a distribution system adequate to its needs.

The system under consideration is owned and operated by the Cia. Mexicana Productora de Luz y Fuerza, S. A., a company composed entirely of Mexican capital.

This property was bought from the El Paso Electric Company in the early 1930's, and no work or definite planning was done until late 1946. Line work consisted of small service extensions, trouble shooting, and meter installations, all of which was taken care of by two small crews. However, during the time of World War II, a very marked increase in population was noted, and rapid expansion made necessary drastic changes in distribution construction and planning.

In 1948, a map of the city was made up, showing existing distribution feeders. In this way a clear picture was obtained of the existing 2,400-volt delta system fed by three 13,800/2,400-4,150-volt substations, as well as secondary areas, all constructed on a radial basis, and an embryo 13.8-kv system used solely to feed the existing substations. This 13.8-kv feeder was taken from the El Paso Electric Company generating system, but the company also had an additional feeder from the El Paso system at 2,400 volts. This additional feeder took care of the old or central section of the city, while substations took care of outlying districts. Substation capacities were 1,500, 1,500, and 2,250 kva, while the old 2,400-volt feeder took care of approximately 1,400 kva. Maximum demand for 1948-49 was 5,400 kw.

The 1950 boom in the lumber industries, the steady growth of the meat packing industry, and the yearly cotton yield, each helped to render the old 2,400-volt distribution system obsolete. New loads in cotton gins, processing plants, lumber mills, and packing houses demanded an adequate supply network.

In 1950, the federal government, through the Comsion Federal de Electricidad (Federal Power Commission), installed three 5,000-kw units for generating purposes, to complement imported power. This step, in turn, led to the construction of a 13.8-kv system, already planned, to feed the various loads.

It was decided that all new services classified as industrial would be handled by the 13.8-kv system; overloading of existing substations would be solved by changing residential areas to 13.8 kv; all substations would be changed to 4,160 volts Y. This program was approved and work started in the fall of 1952.

In the planning of new secondary areas, a system was worked out in which consideration was given to the actual life expectancy of the area as an efficient unit of the system. Since it is practically impossible to predict loads for every area of every sector, the calculations as to wire size were done on a single-phase basis, thereby making the area flexible enough to accommodate a substantial increase over its original load. It was planned that future growth would be taken care of by feeding off the Y system of the secondary. This would be done only in residential areas. Whenever possible, small industrial services were fed from a separate bank, thus having an added advantage in growth capabilities. All residential services were given in the established 3-wire manner; industrial services were given from a closed-delta bank, 3-phase 3-wire power service, and 3-wire lighting.

This procedure has been followed through the years in all new projects and the reconstruction of the old. A fantastic reduction in area of substation feeders has been accompanied by an increase in load. The 4,160-volt areas now cover only about 10% of the total area of the city but their load has been kept up to 110% capacity on maximum demand. The maximum demand of the system has gone from 5,400 kw in 1949 to 25,000 in 1958.

It is readily seen that even though work on new electrification has been going on at a constantly increasing pace, it has failed to keep up with the growth of the city itself which has gone from 60,000 population in 1946 to almost 250,000 in 1958. As it is, 50% of the city lacks adequate distribution facilities. These areas will be serviced by new electrification projects which are to begin in 1959.

Together with the problem of keeping up with the load, there also exists the problem of the actual construction of overhead lines. This situation arises through the total absence of service alleys, which places the companies in a position of

Future Meetings of Other Societies

Association for Computing Machinery, 14th Annual Meeting, Sept 1-3, MIT, Cambridge, Mass. J. H. Wegstein, ACM Program Committee, NBS, Washington 25, D. C.

IES, National Technical Conference, Sept 7-10, Fairmount & Mark Hopkins Hotels, San Francisco, Calif. IES, 1860 Broadway, New York 23, N. Y.

SPI, Midwest Section Conference, Sept 10-11, French Lick Sheraton Hotel, French Lick, Ind. L. P. Williams, SPI, 250 Park Ave., New York 17, N. Y.

IAS, Western Regional Meeting on Frontiers of Science and Engineering, Sept 16-17, Los Angeles, Calif. IAS, 2 E 64 St, New York 21, N. Y.

International Federation of Automatic Control, General Assembly, Sept 16-18, Evanston, Ill. Harold Chestnut, General Electric Co, Schenectady, N. Y.

2nd Conference on Nuclear Radiation Effects on Semiconductor Devices, Materials and Circuits, Sept 17-18, Western Union Auditorium, 60 Hudson St, New York, N. Y. Security clearance not required. B. Reich, Solid State Devices Branch, ECRD, U.S.A.S.R.D.I., Ft Monmouth, N. J.

SFSA, 57th Fall Meeting, Sept 21-22, The Homestead, Hot Springs, Va. SFSA, 606 Terminal Tower, Cleveland 13, Ohio.

ISA, 14th Annual Instrument–Automation Conference and Exhibit, Sept 21-25, Palmer House, Chicago, Ill. H. S. Kindler, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

Armour Research Foundation, joint *Nucleonics* magazine, 3rd Industrial Nuclear Technology Conference, Sept 22-24, Morrison Hotel, Chicago, Ill. L. Reiffel, ARF, Technology Center, Chicago 16, Ill.

AIChE, 41st National Meeting, Sept 27-30, Hotel St. Paul, St. Paul, Minn. W. M. Poda, Economics Laboratory, St. Paul, Minn.

The Institute of Radio Engineers

National Symposium on Space Electronics and Telemetry, Sept 28-30, Civic Auditorium & Whitcomb Hotel, San Francisco, Calif. Robert De Leban, 1015 Lemon Ave, Menlo Park, Calif.

5th National Communications Symposium, Oct 5-7, Hotel Utica, Utica, N. Y. Oct 8: classified symposium, Griffiss Air Force Base, Rome, N. Y. *Confidential clearance required.* J. R. Bernard, Glen Rd, N, Rome, N. Y.

AWS, Fall Meeting, Sept 28–Oct 1, Sheraton-Cadillac Hotel, Detroit, Mich. A. L. Phillips, AWS, 33 W 39 St, New York 18, N. Y.

Overseas

International Conference on the Application of Large Radiation Sources in Industry, International Atomic Energy Agency, Sept 5-11, Warsaw, Poland. Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn.

The Yugoslav Association for the Protection of Material, International Conference for Protection of Hydroelectric Power Plants and Equipment, Sept 14-16, Belgrade, Yugoslavia. Organizing Committee, above conference, Kneza Milosa St., No. 7/III, P.O. Box 771, Belgrade, Yugoslavia.

The Institute of Physics, Conference on Some Aspects of Magnetism, Sept 22-24, Sheffield, England. Conference Secretary, Inst of Physics, 47 Belgrave Sq, London, SW 1, England.

2nd Congress of the Société Française des Electriciens, Sept 24-27, Aix-les-Bains, France. Société Française des Electriciens, 10, Ave Pierre-Larousse, Malakoff (Seine), France.

having to run primary and secondary lines through streets and alleys alike, with the consequent eyesore of service lines, transformers, etc. The best has been made of a bad situation by use of the most modern construction in overhead lines and avoiding, as much as possible, crossings of service wires in the main streets. Special attention is also given to routing of high-tension lines through secondary streets, and the installation of transformers in out-of-the-way locations, where possible.

This new investment has not been in vain; the public responded in a surprising way. All the old areas which had never had more than a few kilowatts load when low voltages were used, overnight tripled and quadrupled their load when efficient service was given.

The work described up to this point deals entirely with reconstruction and new electrification of all areas surrounding the central zone or old town. In common with a great majority of Mexican cities, the central zone of Ciudad Juarez presents quite a problem in modernization. This area is earmarked for either an overhead or underground network. With this in mind, planning has been channeled to take into account existing substations for use in this area when they are retired from feeding existing loads which, in turn, are being changed to the new 13.8-kv system. This zone includes the section for which Cuidad Juarez is more widely known, but which represents a very small part of the city. It caters almost exclusively to the tourist trade, occupies an area of six city blocks on two streets, and has a load of 800 to 900 kw on maximum or peak load.

The main problem of supply, then, has been satisfactorily solved in Cuidad Juarez with the changeover to 13.8 kv. In common with all growing cities, changes in distribution will have to be made to accommodate newer and heavier loads which, undoubtedly, will be added in the near future. This, however, will be solved by division of existing circuits. In this division of feeders, the unit area principle is also applied. It was found that for this particular city and the distances involved, the most convenient load per 13.8-kv feeder is about 5,000 to 6,000 kva. Keeping the load per feeder close to this figure results in an efficient circuit, very good regulation, and the ability to introduce maximum flexibility in normal or emergency feeding.

NSF Announcement

The National Science Foundation (NSF) announces a new program for support of renovation and/or construction of graduate level (doctoral) research laboratories in the natural and engineering sciences at institutions of higher education. Generally speaking, equipment to be supported will be limited to standard fixed equipment (e.g., laboratory benches, built-in refrigerators, etc.), whether the grant is for construction of a new laboratory or the renovation of an existing one.

Proposals pertaining to laboratories for research use in any area of the basic sciences will be considered. However, the NSF will not consider requests for support of facilities to be used primarily for instructional purposes.

Grants made under this program will require matching by the institution, from non-Federal sources, to the extent of at least 50% of the direct costs to be incurred. During fiscal year 1960 (July 1959 to June 1960), funds for this program will be severely limited in amount. Accordingly, it is expected that it will be possible to meet only the most urgent needs.

Proposals should be submitted to the National Science Foundation, Washington 25, D. C., by December 1, 1959. In most cases, it will be helpful to address an inquiry to the appropriate Division of the NSF before preparing the proposal. (For the physical sciences, the appropriate division is the Division of Mathematical, Physical, and Engineering Sciences; for the life sciences, it is the Division of Biological and Medical Sciences.) It is anticipated that grants under this program will be made about June 1, 1960.

Static Switching Device Has Wide Range of Applications

A MISSILE MISSFIRES at Cape Canaveral. An automation production line suddenly stops. An airplane "bellies in" with its landing gear up. Common and apparently unrelated incidents such as these may often be traced to a single source of trouble—the failure of some seemingly insignificant but actually all-important switching device to open or close an electric circuit.

While intensive efforts have been made to improve conventional control devices—such as contact-type switches, magnetic amplifiers, tubes, transistors, etc.—it has long been known that an entirely new approach to static switching would be required to fulfill present and future needs of modern technology.

Such a radically new switching device—basic in concept and possessing inherent characteristics which promise to have as great an impact on high-power circuit control applications as transistors have had in the low-power field—was unveiled recently in a demonstration by its inventor, S. R. Ovshinsky, president of Ovitron Corp., Detroit, Mich.

Based upon unique and hitherto unrecorded electrochemical phenomena which assure unprecedented reliability, the the small but rugged Ovitron control unit was described as being the first device ever developed which is inherently capable of switching and modulating almost any amount of alternating current endlessly and continuously without wear, disintegration, or loss of efficiency; and without moving parts, magnetic coils, or other bulky, costly amplifying apparatus.

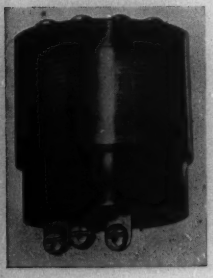
Principle of Operation

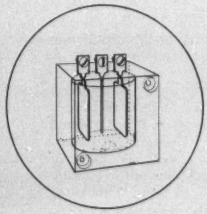
Inspired in part by a theoretical study of the metabolism and function of the neuron, or individual nerve cell, the Ovitron static switching device consists simply of two load-connected electrodes and a grid control element, all three of which are immersed in a electrolytic bath permanently sealed within an encapsulated container.

Upon application of a small energy stimulus introduced through the grid element, the semipermeable surfaces of the two load electrodes become permeable to certain ions and are instantaneously changed from their nonconductive state to a conductive state, thus allowing large amounts of a-c to flow from one electrode to another through the medium of the electrolyte.

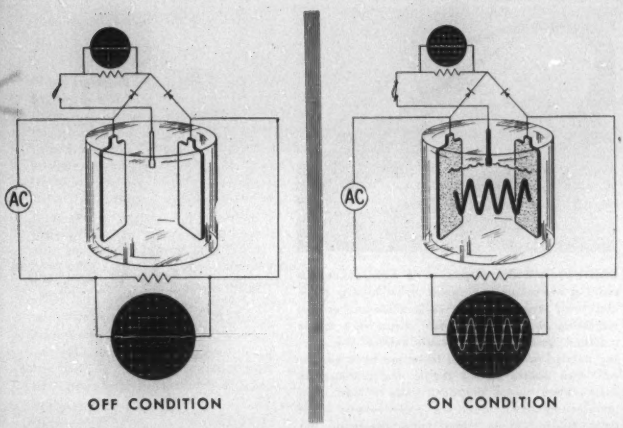
The high-wattage load current is controlled entirely by the small energy stimulus, in a manner which permits either full-on, full-off switching or modulation to occur. Moreover, modulation can be of the continuous type without harmful effects on the unit or its operating characteristics.

When the control signal is removed from the grid control element, or when another signal of opposite polarity is applied, the conductive surfaces of the load-carrying electrodes are immediately restored to their original nonconductive state, thereby





TYPICAL Ovitron electro-ionic static control unit. *(left)*. Unit ratings per single cell: load voltages —3 volts a-c minimum, 70 volts a-c maximum; load currents—range from milliamperes to 15 amperes. Multiple cell control units may be supplied to obtain higher ratings as required. Drawing *(right)* shows internal elements of an encapsulated Ovitron control unit.



SCHEMATIC DIAGRAM of Ovitron amplifier. A self-energized method of excitation can be achieved through the use of two diodes which block a-c to the grid control circuit and allow the application of pulsating d-c potential of the proper polarity upon the grid and load-connected electrodes. These diodes can be very small and inexpensive with nonrigid specifications because they are only required to handle the small control current. They are not involved in passing the output portion of the circuit in any way whatsoever. By using a variable resistor instead of a switch, the magnitude and potential of the control signals can be controlled to achieve modulation of the load circuit.

effectively blocking the flow of current through the unit.

Range of Potential Application

Although the Ovitron concept of "control through electro-ionic surface impedance changes" is still much too recent a development to have found its full range of potential applications, its basic simplicity and phenomenal reliability are known to make it readily adaptable to perform a wide range of high-power a-c control functions for commercial, industrial, and military use.

As an indication of the extreme versatility of the basic principles involved, working models of Ovitron control units have been developed and applied in laboratory tests for functional use as proximity switches, logic devices, modulators, circuit breakers, error detectors, amplifiers, regulators, and time delays.

Multibeam Radar System Supplies Data at Longer Ranges

The first in a series of new high-power multibeam radar systems was recently delivered to the U.S. Air Force for operational use by the Air Defense Command, it was announced by J. J. Farrell, general manager of the General Electric Company (GE) heavy military electronics department, Syracuse, N. Y.

Designated the *AN/FPS-7*, the radar system is capable of detecting aircraft at significantly higher altitudes and longer ranges than present-day air defense radars. It will supply radar data to the SAGE Continental Air Defense System.

The *FPS-7* was designed and developed for the Air Force by the Air Research and Development Command's Rome Air Development Center, Rome N. Y., in conjunction with GE.

Mr. Farrell explained that the *FPS-7* provides much faster target data on approaching aircraft than is possible with the conventional system. This data is relayed to the computers at the same time, eliminating the present interdependency of one radar on another and speeding up the calculation of intercept data. This factor is increasingly important in this age of high-performance long-range supersonic aircraft, when human errors or excessive time in computation of radar data and the transmission of weapon control commands could be disastrous.

The *FPS-7* features a unique "varifocal" antenna design. It operates on a multibeam principle whereby several narrow beams are fed to the antenna, as compared with the standard single-broad-beam method.

The r-f power for the *FPS-7* system is generated by a 5-foot-high klystron tube developed by the Rome Air Development Center and GE's power tube department. This multimillion-watt tube produces hundreds of times more power than the radar that was used to beam pulses to the moon and back in 1946. Its frequency limits can be held much closer than the frequency limits of ordinary radio and television transmitters operating in the United States, greatly increasing the versatility of the over-all system, Mr. Farrell said.

A supersensitive antenna, which weighs approximately 7 tons and rotates a complete 360 degrees, focuses the high-power pulses of r-f energy emitted by the *FPS-7*. Its sail or reflector measures 40 feet by 18 feet.

In addition, the *FPS-7* includes 52 cabinets of electronic equipment. Printed circuitry and plug-in type units have been used wherever possible to simplify maintenance and increase system reliability.

The over-all system is housed in an

◄ MULTIBEAM radar system, the *FPS-7*, detects air targets at greater ranges and higher altitudes than present-day air defense radars. It is used to determine target data for the USAF's SAGE Continental Air Defense System. Shown testing the *FPS-7* at GE's Heavy Military Electronics Test Center is engineer J. A. Wall. Feed horn at right focuses the high-power r-f pulses on the antenna screen, which measures 40 by 18 feet.

arctic tower with a 50-foot radome to protect the antenna from wind, snow, and ice. The radome is designed to withstand winds in excess of 100 mph. It is fabricated from neoprene-coated nylon fabric in the shape of a ¾ sphere 55 feet in diameter. The radome is supported over the antenna by air pressure of approximately ⅓ pound per square inch.

Meter-Relays Use CR Design Principle

Meter-relays with a new design principle, retaining the reliability of locking contacts but providing instantaneous reset, have been developed by Assembly Products, Inc., Chesterland, Ohio.

With the new CR (continuous reading) design, the moving pointer shows the signal level at all times, even when the set point has been passed and control circuits have been energized. The circuits remain operative until reset calls for opposite action.

Since this feature adds an important operating advantage to locking contact meter-relays, it is expected to extend their application to many new fields. In addition, the new design greatly simplifies the circuitry used with such meter-relays.

As in present meter-relays, a separate coil increases control dependability by boosting contact torque at set point, thus insuring positive actuation of a load relay.

In applications using the CR meter-relay, control action is directly linked to the signal and is, therefore, much smoother, faster, and more foolproof than was formerly possible. Since "sampling" the signal is not necessary, a number of auxiliary control components can be eliminated, such as interrupters, condensers, and resistors.

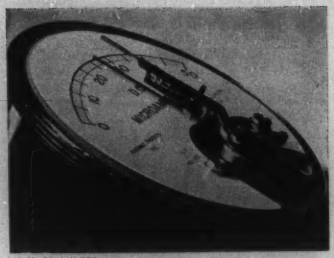
Meter-relays with this design may be used in virtually any application requiring only one set point. Sensitivities are the same as those of existing meter-relays, beginning with full-scale ranges of 0 to 5 microamperes. Any of the present meter styles may be specified.

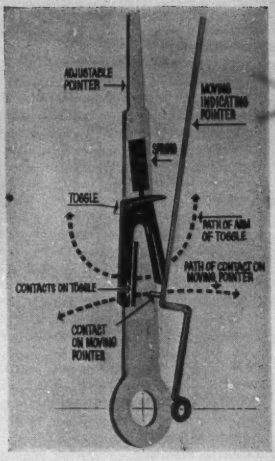
Key to the new design is a V-shaped toggle, with contacts on each of its arms. The toggle is pivoted on the under side of the adjustable pointer that marks the set point. Both the toggle and the adjustable pointer are made of layers of isolated metal that are parts of separate circuits from the respective toggle contacts.

When the indicating, or signal pointer reaches set point, a two-stage action occurs, almost instantaneously:

1. A contact on the pointer touches a contact on the toggle and a circuit is closed through both the booster coil and the coil of a multipole load relay. The booster coil assures firm meter-relay contact action.

2. As the load relay initiates the desired control action through one set of contacts, another set closes and pulls a surge of current through the meter-relay movement. Thus, enough torque is added to the indicating pointer to cause it to snap the toggle and move past it. The meter-relay contacts are then separated and the booster circuit is opened. This sequence of action may begin at either high or low limit.





CONTROL ACTION begins in a new continuous reading meter-relay designed by Assembly Products, Inc., when a round vertical contact on the indicating pointer meets a flat contact on a toggle mounted beneath the adjustable pointer. The moving pointer, with its torque increased by a booster coil, then passes by the toggle and continues to show actual signal strength, while a load relay remains energized. When the signal returns to set point, the indicating pointer snaps the toggle the other way and reverses the control action.

The load relay remains energized as long as the signal is higher (or lower) than set point. The indicating pointer moves freely with fluctuating signal strength.

When the indicating pointer returns to set point, its contact again touches a contact on the toggle. A circuit including the booster coil is closed and the load relay is dropped out. The indicating pointer snaps the toggle the other way and again pushes past, opening the booster circuit once more.

The design and positioning of the toggle are such that a contact on the indicating pointer always passes by the toggle arm closer to it and strikes the contact on the further arm. The indicating pointer has two isolated contacts, one touching a toggle contact while moving upscale, the other being operative when the pointer moves downscale.

Movement of pointer contacts across the toggle contacts exerts a wiping action that keeps contacts clean and makes for more positive action and longer contact life.

"Convertiplane"— A Dual-Purpose Aircraft

An aircraft that hovers like a helicopter, but flies as far and as fast as a propeller-driven plane, was described at the recent Semiannual Meeting of The American Society of Mechanical Engineers (ASME) in St. Louis, Mo., by C. E. Leibensberger, project flight test engineer for the Bell Helicopter Corp., Fort Worth, Texas.

The vehicle, called a "convertiplane," has propellers that can be used vertically, horizontally, or at any position in between. For tight-squeeze take-offs or reconnaissance, the pilot aims the propellers straight up. For high-speed long-distance flight, he tilts them forward. The plane will be able to range over 3,000 miles and, because it could land in downtown city areas, could result in faster trips than any long-range planes, except jets. It is expected to have a cruise speed close to 350 miles per hour. The plane can be used for observation, reconnaissance, and rescue missions; larger versions for utility, assault, and transportation.

In addition, if the plane is used as a "straight" aircraft—with propellers forward—tests indicate that it will be able to take off within 500 to 600 feet with a 150% increase in cargo over the helicopter version. The additional power built in for helicopter use can push the plane up in a shorter time than it would take a conventional aircraft to rise. Expected helicopter cargo versions will carry 2 to 3 tons; the short take-off and landing versions will be able to handle 4 to 6 tons.

The pilot makes the propellers rotate upward or forward by moving an electromechanical conversion switch. He can stop the operation at any point. The whole maneuver can be completed in 12 seconds.

The pilot also has a gear shift so that he can use high engine speed for helicopter and initial plane configuration and lower engine speed to increase propeller efficiency and long-range economy once the props are in forward position.

A moderate-powered prototype of the plane has been tested successfully and the future for the dual-purpose plane looks bright, said Mr. Leibensberger.

In another paper presented at the same session of the ASME meeting, J. B. Nichols of the Hiller Aircraft Corp., Palo Alto, Calif., described a second dual-purpose plane that moves its wings up and down, instead of its propellers. The "propelloplane" will have turboprop engines and is designed for the same purposes as the convertiplane.

CORRECTION: On p. 495 of the May 1959 issue of *Electrical Engineering*, the caption under the photograph of the Stromberg-Carlson *S-C 5000* electronic printer should read 85,000 words per minute, rather than 85,000 characters per minute.

Electronic Memory Unit at U. S. Exhibition in Moscow

A capsule trip to the United States via electronics is available to Soviet visitors to the American National Exhibition in Moscow which began on July 25 and will continue through September 4. Their guide is an IBM RAMAC *305* data-processing machine set up in the United States Pavilion to answer in Russian thousands of inquiries on every aspect of life in the United States.

Like the RAMAC which produced historical facts in 10 languages for visitors at the 1958 Brussels World's Fair, this "electronic encyclopedia" has a giant memory unit composed of a stack of 50 spinning magnetic disks on which 5 million characters of information can be stored as tiny magnetic spots. For the Moscow exhibition, RAMAC's disk memory has been filled with the equivalent of a million words of facts and figures about the United States—approximately the contents of a 1,000-page printed volume.

Information about America concentrated in the giant RAMAC memory falls into eight general categories—The American People, The American Land, How Americans Live, Americans at Work, American Education and Culture, American Science and Technology, the American Economy, and Americans and the World. The written material was compiled by the U. S. Information Agency.

The machine is ready to anticipate the simplest, as well as the most sophisticated question about the United States—from the number of American cities named "Moscow" to the daily consumption of water. A visitor interested in "Education," for example, may look up this category on one of several panels near RAMAC. He notes the number of a question he wants answered, such as "How many engineering schools in America." He then types this number at one of the four electric typewriter "inquiry stations," or he can give his question to one of the Russian-speaking American guides nearby. RAMAC receives the question, consults its memory, and in only a few seconds automatically types out the answer in Russian. The answer appears both on the electric typewriter and on a television screen above it.

Manufactured at the San Jose, Calif., plant of International Business Machines Corporation, the 5-ton computer consists of 12 separate units linked together by cables.

The Moscow exhibit is part of the U. S. State Department-sponsored series of intercultural exchanges. The Soviet exhibition took place in New York City's Coliseum from June 30 to August 10. In the field of electronics, they displayed some of the most typical examples of radio electronic apparatus designed and produced at Soviet plants, including television and radio sets, tape recorders, electric vacuum instruments, transistors, and tubes. A model of the Stalingrad hydroelectric power station was exhibited as part of the power display, as well as a model of the hydroturbogenerator of the Kuibyshev hydroelectric power station, and others.

Construction Begun on Zero Gradient Synchrotron

Construction of a 12.5-billion electron volt particle accelerator to probe the structure of matter was begun recently at the Argonne National Laboratory near Lemont, Ill. At the request of the U. S. Atomic Energy Commission, Congress authorized the design and construction of the machine, called the Zero Gradient Synchrotron (ZGS).

Expected to be completed early in 1962, the machine will be capable of producing all known subatomic particles at the will of its operators. A 50-million electron volt linear accelerator will be employed to inject charged particles into the new synchrotron. This will have a resonant cylinder 37 inches in diameter and 110 feet long.

The ZGS will use protons as "bullets," accelerating them to an energy of 12.5 bev (billion electron volts) before sending them crashing into target atoms. The machine will serve two basic purposes: (1) to provide a wide variety of subatomic particles; and (2) to serve as a "microscope" for examining these particles.

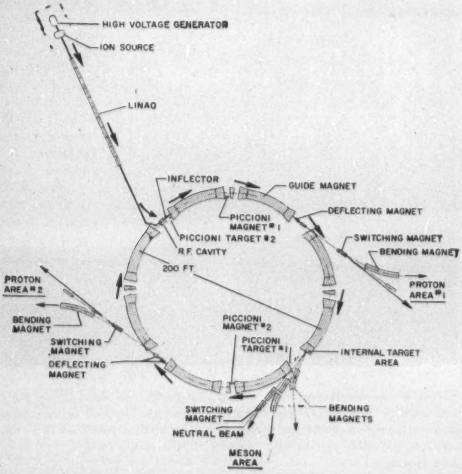
The ZGS will be housed in a ring-shaped building 200 feet in diameter, containing a huge magnet arranged in eight sections (octants) around the outside of the circle. Protons will travel through a small rectangular aperture in the center of the magnet. This "doughnut" will be shielded with a mound of earth, as a protection against possible radiation during operation of the machine.

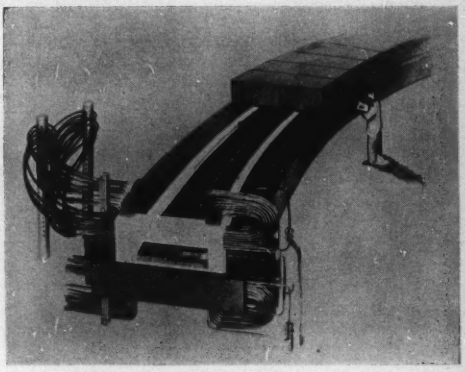
In operation, protons first will be accelerated to 800 kv by a standard high-voltage source. From there, they will go into a linear accelerator, a smaller atom smasher which accelerates particles in a straight line, rather than whirling them around in a circle. The protons will attain 50 mev (million electron volts) in the linear accelerator, and then will be introduced into the ZGS in short, well-regulated bursts. The ZGS will accelerate them to 12.5 bev in one second.

The particles can be removed into experimental areas at any time after their entrance into the ZGS. Two proton study buildings and a meson building will be constructed for this purpose.

The ZGS site will include an equipment structure located inside the "doughnut" accelerator ring, a laboratory and office building, and a shop and assembly structure. A cooling tower will provide the cooling water necessary during operation of the ZGS magnet.

Another new facility announced by Argonne is the recently dedicated Fuel Fabrication Facility, the culmination of more than 3 years of design work by Argonne staff members and 2 years of construction effort. The new facility was designed to make possible developmental research on techniques for fabricating plutonium fuel elements. It also will be





COURSE of a particle through Zero Gradient Synchrotron, to be constructed at Argonne National Laboratory, is pictured in sketch (*left*). Drawing (*above*) shows magnet octant, with coil assembly and vacuum chamber.

used to fabricate experimental plutonium fuel elements for several of the Laboratory's nuclear reactors.

Four types of work will be carried out in the new building: (1) fabrication or work directly on plutonium fuel cores for nuclear reactors; (2) assembly, welding, and bonding of previously fabricated plutonium cores into nonradioactive jacket materials; (3) metal working, machining, cutting, or heat treating operations on the jacketed pieces; and (4) inspection or other operations upon finished fuel elements for which no protection is required.

Biomedical System Gives Data on Space Mice

The flight of the mice who journeyed into space aboard the Discoverer III satellite will shed light on what America's first man in space may expect. What has been learned of the physiological reactions of the mice to space travel will be applied to man's first space trip.

Designed for the purpose of gathering all pertinent data is a complex mobile, bio-medical system built by Consolidated Diesel Electric Corp., Stamford, Conn., for Lockheed Aircraft Corporation's Missile Systems Division.

In a fence-enclosed area on the U. S. Air Force's Vandenberg base in California is the cluster of six oversized stainless steel highway vans. Inside each of the air-conditioned trailers is specialized equipment comprising a system designed to apply the latest methods of medical and electronic sciences to obtaining information about the physiology of animals destined for space flights.

Two of the trailers are identical biomedical laboratories. They contain complete living quarters, including sleeping, eating, and sanitary facilities, for scientific personnel; cages for animal specimens; an exercise area for animals; examination area, including treatment table; a medical laboratory area including X-ray and darkroom facilities; and a chemical laboratory. Another van contains an altitude chamber capable of simulating altitudes as high as 200,000 feet.

Built by Consolidated Avionics Corp., Westbury, N. Y., Con Diesel's electronic subsidiary, the fourth trailer houses a maze of complex instrumentation designed to convert telemetry signals from the specimens into forms suitable for study and recording.

The fifth and sixth vans are serv' units, making the system completely self-sufficient. In one is a complete electric generating plant which furnishes necessary power to all the other trailers. The other is a complete workshop fully equipped with the tools for making repairs to the equipment in any of the other vans, even fabricating metal parts should it become necessary. In the work shop unit are additional living quarters for operating personnel.

The six vans are interconnected by power cables, by an intercommunication system, and by signal cables which carry information from the altitude unit and biomedical vans to the instrumentation van for processing into usable data.

In preflight operation, the unit is used to determine normal reaction of specimens to ordinary conditions of rest and exercise and to conditions encountered at simulated higher altitudes.

A variety of biological and physiological data can be obtained. The information is generated by sensing the various conditions of the specimen at any given moment and translating the data into electric impulses which are transmitted by cable to the instrumentation van.

Since the signals appear in many different forms and voltages, depending on the particular associated physiological function, the primary purpose of the instrumentation van is to convert the signals into "common language" forms suitable for study, recording, and reproduction.

Many of the signal circuits are in a suitable form (varying d-c voltages) for use without further processing, and others can provide conditioning for signals not ordinarily capable of being recorded into usable form.

Input signals are fed to a patchboard at the operator's console. The operator can feed any given input to a variety of recording and analyzing equipment. For immediate visual study, data can be routed to a number of oscillographic recording channels. For storage in electrical form for later reproduction, magnetic tape recorders are provided. Presently installed analog magnetic recorders have seven channels of direct recording capable of handling frequencies above 50 cycles per second and channels of frequency-modulated recording for lower frequency information.

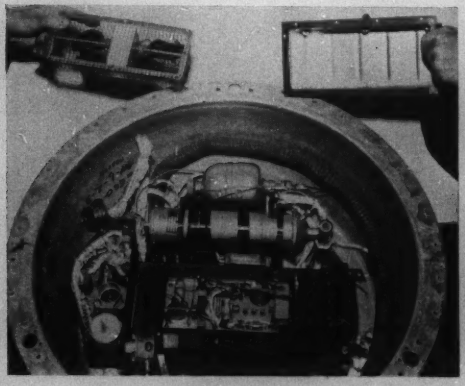
For information most usable in digital rather than analog form, conversion equipment is provided to digitize the information before recording on digital recorders. Digitized recorded information can also be reconverted into analog form for oscillographic reproduction.

Magnetically recorded information can be visually reproduced later by being played back into oscillographic recorders, can be stretched to provide a "magnified" view of significant sections, can be fed directly into computers for analysis, or can be fed into correlating equipment for automatic comparison with previously obtained data or with established standards.

Voice recording facilities are also provided so that observers can make on-the-scene observations with free hands. If recovered, the specimen can be returned to the complex for further study.

ASTM Chooses Rad as Standard Radiation Dose Unit

The Joint Subcommittee on Radiation Effects, composed of American Society for



FOUR MICE who flew into space in Discoverer III are shown with the life support system which housed them. Built by General Electric, the vehicle contains instrumentation to monitor pressure, temperature, relative humidity, acoustic noise, and acceleration; electrocardiogram; and cosmic radiation plate.

HEART of the biomedical system delivered by Consolidated Diesel Electric Corp. to Lockheed is this instrumentation van. The unit accepts data derived from the altitude chamber, from the medical vans, or from the satellite receiving station and converts it into forms suitable for study and recording.

Testing Materials Committees on Electrical Insulating Materials and on Plastics, has recommended the use of the rad as a national standard unit for reporting radiation dose. The rad, which represents 100 ergs of energy absorbed per gram of material, is independent of the kind of ionizing radiation (X rays, gamma rays, beta rays, neutrons, etc.) as well as of the type of material being irradiated. In this respect, the rad differs from most other units currently in use for measuring radiation intensity and radiation effects. For example, the well-known roentgen unit applies only to X and gamma radiation absorbed by air.

In order to use the roentgen as a unit for measuring exposure to radiation of materials or tissues other than air, it has been found expedient to use a modified unit such as the rep (roentgen equivalent physical). The rep was originally defined as the dose of any nuclear or ionizing radiation resulting in the absorption of 93 ergs per gram of tissue. The energy equivalent of the rep has been changed in recent years to 98 ergs per gram because of more accurate measurements.

In recommending the use of the rad as the standard radiation dose unit, the committee is recognizing what was expected in 1953 by the International Commission on Radiographic Units when it adopted the rad as a new unit of absorbed radiation dose. It was expected then that the rad would eventually supersede the rep which has been widely used in reporting radiation dosage. This action of the committee to recommend a national standard unit, if widely followed, will improve communications among those reporting results of experiments on radiation effects.

Report on CIE Brussels Session

The 14th Session of the Commission Internationale de L'Eclairage (CIE) was held in Brussels, Belgium, June 15-24, 1959. More than 500 delegates from 24 countries, including 52 delegates from the United States, attended the Session. New officers were elected to serve for the 4-year period ending in 1963, when the 15th Session of the CIE will be held in Vienna, Austria. The new officers are as follows: Ivar Folcker (Sweden), president; A. A. Brainerd (United States), vice-president; R. Deaglio (Italy), vice-president; L. Fink (Austria), vice-president; L. Schneider (Germany), vice-president; W. W. E. Von Hemert (Netherlands), treasurer; and Y. LeGrand (France), secretary.

The results of the work transacted and reported upon at the technical meetings and the papers which were presented, as well as the discussions thereon, will be published in a Proceedings which will be available early in 1960.

Several technical Recommendations were tentatively approved. These become effective 6 months after their tentative approval unless objection is entered by any National Committee. Anyone desiring to comment on or object to any of these Recommendations should communicate with L. E. Barbrow, Secretary of the U. S. National Committee, CIE, National Bureau of Standards, Washington 25, D. C. The limiting date for comments or objections is October 1, 1959.

A limited number of copies of the document which includes the tentatively approved Recommendations is available from Mr. Barbrow, as is a complete list of the papers and technical committee reports presented at Brussels, and preprints of those documents at a nominal price.

Recommendations were made on the subjects which follow. (E Committees are Committees of Experts and S Committees are Secretariat Reporting Committees.)

Committee S-1.2, Measurement of Light
Committee E-1.3.1. Colorimetry
Committee S-1.4.1. Photopic and Scotopic Vision
Committee S-2.1.1. Sources of Visible Radiation
Committee S-3.1.5. Mine Lighting
Committee S-3.3.2.2. Lighting for Transport other than Automobile and Air

Committee E-1.1, Vocabulary, reported that it had recently published Vol. II of the International Lighting Vocabulary. Vol. II gives, for each term defined in Vol. I, the equivalent term in French, English, German, Danish, Dutch, Italian, Polish, Russian, Spanish, and Swedish. Copies of Vol. I and Vol. II are available from L. E. Barbrow, at the previously mentioned address.

TRIGA Reactor Installed in Belgian Congo

The atomic age came to the Belgian Congo recently with the formal dedication of a TRIGA research reactor which was placed in operation at the University of Lovanium, atop Mount Amba, 15 miles south of Leopoldville on the Congo River. It is the first atomic reactor to be installed and operated on the African continent.

The TRIGA, conceived and produced by General Dynamics Corporation's General Atomic Division, is the same reactor which was a feature attraction of the U. S. Government's technical exhibit at the Second International Conference on the Peaceful Uses of Atomic Energy at Geneva, Switzerland, in 1958. Following the Conference, where the TRIGA was seen in operation by thousands of scientific delegates and other visitors, the reactor was acquired by the University of Lovanium and shipped there from Switzerland for reassembly.

The University of Lovanium TRIGA has a steady-state operation power level of 10 to 30 kw and can be operated intermittently at power levels up to 100 kw. The reactor is distinguished by its great degree of inherent safety, its simplicity and versatility, and its ability to provide a large variety of medium and short-lived radioisotopes of useful specific activity for use in the University's medical and science courses and for agricultural research. It will serve as an important tool in activation analysis, in physical chemistry work, and radiobiology.

The complete inherent safety of the TRIGA was conclusively verified in recent tests conducted with the prototype TRIGA at the company's John Jay Hopkins Laboratory for Pure and Applied Science in San Diego, Calif. These tests established that, even when great amounts of excess reactivity are inserted, the power level rise is held at a safe level by the prompt negative temperature coefficient of TRIGA's unique fuel elements. This self-controlling safety feature is due to the use of new fuel-moderator elements invented by the company. The elements are a solid homogeneous fuel-moderator alloy of uranium–zirconium hydride, clad in aluminum.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

AMÉNAGEMENTS HYDROÉLECTRIQUES. By R. Ginocchio. Éditions Eyrolles, Paris, France, 1959. 480 pages, 6¼ by 9½ inches, paper. 3,500 fr. Following a discussion of hydroelectric equipment within its historical and geographical framework, the author examines the fundamental principles of hydroelectric structures; the various types of dams; related structures (spillways, gates, conduits, intakes); and turbines and pumps. An appendix discusses the use of scale models in the determination of experimental values and the factors that influence the magnitude of these values.

ANALYSIS OF LINEAR SYSTEMS. By D. K. Cheng. Addison-Wesley Publishing Company, Inc., Reading, Mass., 1959. 431 pages, 6¼ by 9¼ inches, bound. $8.50. The book is a detailed presentation of the two essential steps involved in the analysis of a linear physical system: the setting up of the mathematical equations that describe the system in accordance with physical laws, and the solution of these equations subject to appropriate initial or boundary conditions. In the formulation of the equations that describe a physical system, emphasis is placed upon electric circuits. To deal with systems other than electric, a chapter on analogous systems is included which treats in detail methods for drawing electric circuits analogous to linear mechanical and electromechanical circuits. The Laplace transform method of solving linear differential and integrodifferential equations is stressed.

ANNUAL REVIEW OF NUCLEAR SCIENCE, Volume 8. Edited by Emilio Segrè and others. Annual Reviews, Inc., Palo Alto, Calif., 1958. 417 pages, 6 by 9 inches, bound. $7. This collection of papers surveys recent developments within the field of nuclear science. Such topics are covered as invariance principles of nuclear physics, the optical model, hyperfragments, antinucleons, gamma-ray spectroscopy by direct crystal diffraction, primary cosmic radiation, radioactivity of the atmosphere and hydrosphere, geochronology by radioactive decay, nuclear astrophysics, cellular radiobiology, and information theory in radiobiology.

AN APPROACH TO ELECTRICAL SCIENCE. By H. G. Booker. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1959. 826 pages, 6¼ by 9¼ inches, bound. $9.50. The book presents an integrated approach to electricity and magnetism combining the best methods of electrical engineering, physics, and mathematics. Three broad areas are covered and discussed in detail: electric networks involving any combination of inductors, capacitors, resistors, and vacuum tubes; transmission lines; and electromagnetic theory. A distinction between circuit

theory and field theory is avoided, and an effort is made to use mathematics as a vehicle of thought rather than as a tool. Over 600 problems are included.

AUTOMATION AND SOCIETY. Edited by H. B. Jacobson and J. S. Roucek. Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y., 1959. 553 pages, 6 by 8½ inches, bound. $10. Various aspects of automation are reviewed in this collection of papers which examine the present and potential impact of automation on society. Topics presented include the evolution of automation; its application to critical industries in the American economy; the challenges of automation; and the problems it raises in the areas of education, leisure, politics, and business and public administration. The final paper by two Soviet authors gives a picture of automation in the USSR. A glossary of automation terms and 37 short case histories are also included.

CIRCUIT THEORY OF LINEAR NOISY NETWORKS. By H. A. Haus and R. B. Adler. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1959. 79 pages, 6 by 9¼ inches, bound. $5. The book discusses a method of determining the single-frequency noise performance of an amplifier and its optimization. The properties of linear noisy networks that are invariant under lossless network transformations are analyzed. These invariants are determined for multiterminal-pair networks, and their physical interpretations in terms of a generalized "available power" are presented. The invariants are then considered for the special case of a linear 2-terminal-pair amplifier, and are shown to establish a lower limit on its noise performance. Various ways of achieving this limit are presented for all classes of amplifiers, including those with negative resistance.

CONTROL ENGINEERING. By G. J. Murphy. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1959. 385 pages, 6 by 9¼ inches, bound. $7.50. Modern automatic control theory is covered at an intermediate level. Following a discussion of time response, including a development of Laplace transformations, the characteristics of a large number of control-system components are described, and design in the complex domain is covered. The use of frequency-response techniques, a complete treatment of a-c carrier systems, and the analysis of systems with time lag are presented, followed by sampled-data systems and the statistical analysis of linear control systems. Concluding sections deal with nonlinear control theory and the use of describing functions and the phase plane.

ELECTRICAL MEASUREMENT ANALYSIS. By Ernest Frank. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1959. 443 pages, 6¼ by 9¼ inches, bound. $8.75. The analytical solution of problems arising in electrical measurement is treated from the standpoint of basic concepts. Methods of measurement are classified in two major categories—null and deflection methods—and illustrations in each of these categories are developed with d-c and low-frequency areas, and include high- and low-precision methods. Electronic instruments are only touched upon, with the exception of the diode peak voltmeter. Particular attention is given to the concepts of measurement errors and their statistical treatment.

ELECTRON PHYSICS AND TECHNOLOGY. By J. Thomson and E. B. Callick. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 1959. 527 pages, 5¾ by 8¾ inches, bound. $10. An integrated approach is given to the principles upon which modern electron physics is based. The authors discuss the phenomena associated with free and bound electrons at low and ultrahigh frequencies and with devices which operate by space-change variation. This is followed by a detailed description of microwave and special purpose tubes such as the magnetron, klystron, traveling-wave tube, cathode-ray and storage tubes, and switching and scaling tubes. Concluding sections deal with emitters, phosphors, and with materials and processes for tube construction, vacuum technology, and semiconductors.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 W. 39 St., New York 18, N. Y.

ÉLECTRONIQUE GÉNÉRALE. By A. Blanc-Lapierre and others. Second edition. Éditions Eyrolles, Paris, France, 1959. 504 pages, 6¼ by 9½ inches, paper. 6,700 fr. The first part of this comprehensive presentation of the fundamental physical laws underlying electronic devices deals with the electron and its electromagnetic properties. The second part is concerned with electron emission and discusses vacuum techniques, electron theory of solids, thermionic emission, secondary emission, and photoelectricity. The concluding part deals with electron optics and such applications as electronic lens, electron microscope, microwave tubes, and particle accelerators.

ENERGY FOR MAN. By Hans Thirring. Indiana University Press, Bloomington, Ind., 1958. 409 pages, 5½ by 8½ inches, bound. $6.95. A long-range, nontechnical survey of the production of energy for man's use and the problems arising from the ever-increasing need for power in our technological civilization. The author discusses the major prime movers for power generation and the fuels involved; in addition, he considers solar energy, atomic energy and nuclear reactors, thermonuclear reactions, and heat pumps, with very brief mention of wind, tidal, and geothermal power.

EXPERIMENTAL MUSIC. By L. A. Hiller, Jr., and L. M. Isaacson. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, N. Y., 1959. 197 pages, 6¼ by 9¼ inches, bound. $6. The techniques used to produce music by means of electronic automatic high-speed digital computers are presented. Beginning with a brief discussion of information theory, the theoretical basis of the experimental methods used are established. This is followed by a description of how modern computers operate, and of the mathematical methods used to set up the problem of generating computer music. Detailed descriptions of the experimental techniques and results are given, and the programming techniques for the various musical problems studied are reviewed.

FEEDBACK CONTROL SYSTEMS. By J-C Gille and others. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1959. 793 pages, 6¼ by 9¼ inches, bound. $16.50. This synthesis of the field of servomechanisms combines in a single volume a description of the over-all theory, both linear and nonlinear, and of the components used. The subject matter included falls into two categories, the first constituting a textbook on the basic theory of servomechanisms, and the second dealing with additional data on particular and more advanced methods. Special topics discussed are structural stability, transient response of servo with any nonlinear component, stability of nonlinear systems on the verge of instability, forced oscillations of nonlinear servos, Liapunov's direct method, and describing function with statistical input.

FUNDAMENTALS OF ELECTRICAL ENGINEERING. By F. H. Pumphrey. Second edition. Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y., 1959. 534 pages, 6½ by 9½ inches, bound. $8.50. Following a thorough study of a-c and d-c circuits, the book covers transformers, electric motors and generators, d-c machines, a-c synchronous machines, power rectifiers, feedback control, electron tubes and amplifiers, oscillators, industrial instrumentation, and heating and welding. Additional and new material has been added in this edition on transistors, magnetic amplifiers, d-c machine amplifiers, and sensing units.

HOCHSPANNUNGSTECHNIK. Band I, Teil 1, Gasentladungen, 298 pages, 17 DM; Band I, Teil 2, Hochspannungsmessungen, Hochspannungslaboratorien, 250 pages, 20 DM; Band II, Isolatoren und Isolierungen, 384 pages, 25.80 DM. Edited by L. I. Sirotinski. VEB Verlag Technik, Berlin, Germany, 1955-58. 6¾ by 9¾ inches, bound. This is a German translation of a comprehensive Russian work on high-voltage technology. The three books deal respectively with the following aspects: Vol. I, Part 1—Gas discharges, covering ionization phenomena, discharges in various electrical fields, channel discharge, duration, breakdown voltage, lightning, and corona phenomena. Vol. I, Part 2—High-voltage measurements of all kinds, including surge voltages. Vol. II—Insulators and insulation for high-voltage cables, condensers, transformers, and other electrical equipment, including the pretesting of insulation.

INTRODUCTION TO ELECTRONIC ANALOG COMPUTERS. By J. N. Warfield. Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y., 1959. 175 pages, 6 by 9¼ inches, bound. $6. The basic elements of the analog and digital computer are covered with regard to differences and similarities as well as their applications. The author then reviews differential equations, classifies engineering problems, and indicates how they can be solved by electronic means. This is followed by sections on time and amplitude scaling, simulation of physical systems, problems of stability and sensitivity, generation techniques, and methods of checking analog computer results. The topological aspects of analog computers are stressed through the use of signal flow graphs.

LINEAR NETWORK ANALYSIS. By Sundaram Seshu and Norman Balabanian. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1959. 571 pages, 6 by 9¼ inches, bound. $11.75. The foundations of network theory are developed in relation to steady-state and transient responses, time and frequency responses, and analysis and synthesis. Starting with basic fundamentals, the authors continue with network synthesis, realizability conditions, and feedback and control systems. Specific aspects discussed include computation of network functions from any given real part, magnitude, or angle; integral relationships between real and imaginary parts; method of computing steady-state response for periodic driving functions; general treatment of classical filter theory; and signal flow graphs from the point of view of directed graph theory.

LINGUISTIC AND ENGINEERING STUDIES IN THE AUTOMATIC TRANSLATION OF SCIENTIFIC RUSSIAN INTO ENGLISH. Published by The University of Washington Press, Seattle 5, Wash., 1959. Various pagings, 8½ by 11 inches, paper. $10. The volume reports on research done in the field of automatic language translation of scientific Russian into English. An extensive linguistic study of Russian literature was made in about 40 scientific fields and resulted in the development of an operational lexicon of about 14,000 semantic units. This lexicon was prepared for use in a photoscopic memory device and translation system developed by the International Telemeter Corporation. Part one is concerned with the linguistic analysis of the problem; part two is concerned with the engineering analysis.

THE MANY BODY PROBLEM. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1959. 675 pages, 8¼ by 10½ inches, bound. $15. Papers presented at the School of Theoretical Physics of the University of Grenoble discuss the perturbation theory of many Fermion systems; nuclear structure; many body systems; nuclear matter; collective and spurious degrees of freedom in nuclear models; the Bogoliubov canonical method and its application to nuclei; electrons, plasmons, and phonons; superconductivity; and the hard-sphere Bose gas and the method of pseudopotentials.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

THE MEASUREMENT OF POWER SPECTRA. By R. B. Blackman and J. W. Tukey. Dover Publication, Inc., 180 Varick St., New York 14, N. Y., 1958. 190 pages, 5¼ by 8 inches, paper. $1.85. This review of power spectra analysis is designed for communications engineers, digital computer designers, and statisticians. The book is divided into two parts, the first dealing with the broad aspects of the subject, and the second with certain details and derivations. Continuous records of finite length, equally spaced records, analysis, planning for measurement, and fundamental Fourier techniques are discussed. The present edition is reprinted from the *Bell System Technical Journal* with the addition of an index and a preface.

MOLECULAR SCIENCE AND MOLECULAR ENGINEERING. By A. R. Von Hippel. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1959. 446 pages, 8¾ by 11¼ inches, bound. $18.50. In this, the third and final volume in a series on modern materials research, the fundamental molecular properties of matter and their applications derived by molecular strategy are presented. Beginning with atoms and molecules, it continues with the behavior of charge carriers in gases, the formation and structure of condensed systems, dipoles and their spontaneous alignment in ferroelectrics and ferromagnetics, and ions and electrons in liquids and solids. Among the specific applications considered are gas-discharge and solid-state devices, the molecular concepts producing masers and memory systems, transducers, transistors, parametric amplifiers, and ion-exchange resins.

PRINCIPLES OF CIRCUIT SYNTHESIS. By E. S. Kuh and D. O. Pederson. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1959. 244 pages, 6¼ by 9¼ inches, bound. $8.50. The fundamental concepts of modern circuit synthesis are presented. Beginning with a discussion of circuit synthesis in relation to typical communication and control systems, the authors continue with a discussion of the approximation problem and the basic concepts and techniques of network realization. Two basic synthesis procedures are introduced. In the first procedure, a subdivision is made into the approximation and the realization problems. In the realization problem, emphasis is placed on the removal technique. In the second procedure, basic configurations are cascaded on an image-matched basis. Illustrations and problems are chosen from practical system applications.

RURAL ELECTRIFICATION. Volume III. Published by the United Nations, 1959. Distributed in the United States by Columbia University Press, 2960 Broadway, New York 27, N. Y. 176 pages, 8¾ by 11¼ inches, paper. $1.50. These papers are designed to make available to less industrialized areas the results obtained in countries with experience in rural electrification. Among those topics discussed are the link-up of low- and medium-capacity hydroelectric plants in local power networks, low- and medium-capacity thermal power plants, mechanized methods of constructing and assembling rural power stations, and methods adopted to prevent excess voltage of atmospheric origin.

THE UPPER ATMOSPHERE. By H. S. W. Massey and R. L. F. Boyd. Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y., 1959. 333 pages, 6 by 9¼ inches, bound. $17.50. An account of the phenomena of the upper atmosphere studied during the International Geophysical Year is given. Among the phenomena that receive attention are radio fadeout, radio absorption, night airglow, auroras, meteors, cosmic rays, and the currents responsible for magnetic variations. The effects produced in the atmosphere by the sun, which include the ionized regions important for long-distance radio transmissions, are described in relation to solar phenomena. Also described are the techniques used in investigating these phenomena such as sound and radio waves, spectroscopic devices, searchlights, balloons, and rockets and artificial satellites. Methods of finding the positions and speeds of rockets and satellites, and of interpreting their coded signals are explained.

EJC SURVEY REPORT. A recently completed survey by the Engineering Manpower Commission of Engineers Joint Council (EJC) revealed that over 83% of the estimated 39,000 engineering graduates had completed plans for post-graduation activities a month before June graduation. Compared with the class of 1958 (35,000 engineers), a greater proportion of the graduates in 1959 will pursue graduate studies; similarly, a greater portion accepted employment. There was corresponding reduction in the proportion of those entering military service, and of those without immediate career opportunities. These results are based on data provided by deans of engineering and college placement officers of over 100 colleges in the country, concerning plans of over 18,000 engineering graduates. The survey report may be obtained without charge from the Engineering Manpower Commission, 29 W. 39 St., New York 18, N. Y.

A NOTATION SYSTEM FOR TRANSLITERATING TECHNICAL AND SCIENTIFIC TEXTS FOR USE IN DATA PROCESSING SYSTEMS. Prepared by S. M. Newman, R. W. Swanson, and Kenneth Knowlton, this report describes a special set of "symbols" or notation system which was devised by staff researchers of the U. S. Office of Research and Development of the Patent Office, and Massachusetts Institute of Technology. The system, which is being used in language analysis programs and in research into rapid patent searching methods, is actually a method by means of which the raw text of any publication can be translated into patterns of holes in a punched card or spots on a magnetic tape. It is specifically designed to provide for the specialized letters, symbols, and forms of type which are used in the texts of technical and scientific publications, particularly patent texts. Instructions for preparing a punched card deck, outlines of the programs which are being written for the linguistic analysis, and samples of typical outputs of the program are also described in the report. The report, Patent Office R & D Report No. 15, is available from the Sales and Distribution Office, Rm. 6323, U. S. Department of Commerce, Washington 25, D. C., at 25¢.

THE USE OF Q EQUATIONS TO SOLVE COMPLEX ELECTRICAL NETWORKS. One of the most descriptive and useful concepts involved in selective network studies is the Q factor. These notes on the use of Q equations have been written by H. T. Fristoe to assist the student in his introduction to the concepts of selectivity and matching commonly used in the design of communication networks. Issued as Publication No. 105, the pamphlet may be obtained by writing Oklahoma State University, Engineering Experiment Station, Stillwater, Okla. Price is $2.

INTERNATIONAL ELECTROTECHNICAL VOCABULARY, Group 70, Electrobiology. This expanded second edition was recently published by the International Electrotechnical Commission (IEC), and contains about 110 terms and definitions in French and English, together with the equivalent terms in German, Spanish, Italian, Polish, and Swedish. There is an index for each of the 7 languages. The terms and definitions are divided into five sections: general terms, biological terms, electrotherapeutic terms, current terms, and apparatus terms. IEC Publication 50(70) is available at $2.40 a copy from the American Standards Association, PR Dept. 78, 70 E. 45 St., New York 17, N. Y. The original 1938 edition of the Electrotechnical Vocabulary is also available at $4.50 a copy.

REPORT OF THE TELEVISION ALLOCATIONS STUDY ORGANIZATION (TASO). This report is 731 pages long and includes the principal parts of the reports of the 6 TASO panels, a 28-page summary of the material contained in the panel reports, and a large amount of supplementary material. A limited number of copies of the TASO Report is available at a cost of $10 each. Orders should be accompanied by a check made payable to TASO. Write to: G. R. Town, 104 Marston Hall, Iowa State University, Ames, Iowa.

PROFESSIONAL ENGINEERS' INCOME AND SALARY SURVEY, 1958. One of the features of this survey report, made by the National Society of Professional Engineers (NSPE), is a detailed analysis of salary trends recorded in the four surveys conducted since 1952. Some of the major trends reported in the new survey: all segments of the profession enjoyed further income gains between 1956 and 1958, but engineers connected with the business sector experienced smaller relative gains than those in other types of employment; the gap between earnings in industry, educational institutions, and the Federal Government was narrower in 1958 than it had ever been before; although younger engineers continued to register salary increases, their gains were in line with those of the more experienced engineers, and not considerably higher, as was the case in the past. Copies of the 1958 Survey may be obtained from NSPE Headquarters, 2029 K St., N. W., Washington 6, D. C., at $1 (NSPE members) and $2 (nonmembers).

MICROMINIATURIZATION. The volume reprints 23 technical papers that describe progress in electronic techniques, components, circuits, and semiconductors, which were originally presented at the Diamond Ordnance Fuze Laboratories' "Symposium on the Microminiaturization of Electronic Assemblies." The book is divided into six sections: components, techniques, circuits, semiconductors, missile systems, and microelectronics in industry. The hardbound book, $11 plus 15¢ postage, is available from Hayden Book Company, Inc. (2nd floor), 830 Third Ave., New York 22, N. Y.

METALLIZING HANDBOOK. A new metallizing handbook, containing 345 pages of information, includes the latest developments in the spraying, in powder form, of high melting point ceramics, such as alumina and zirconia, and hard-facing alloys including tungsten carbide. Profusely illustrated, the handbook deals extensively with new automated spraying equipment, electronically controlled, for high-speed production-line spraying as well as with powder spraying, brazing, and soldering, and many other miscellaneous metallizing applications. Clothbound, the book is $5, and may be ordered from Metallizing Engineering Co., Inc., 1101 Prospect Ave., Westbury, L. I., N. Y.

PROCEEDINGS OF THE FIRST SYMPOSIUM ON ELECTRON BEAM MELTING. The 100-page transcript of this symposium held in Boston, Mass., March 1959, includes 15 technical papers from leading United States industrial, educational, and research institutions as well as summaries of 12 papers presented at a similar symposium held in England a few days before the Boston symposium. More than 60 photographs, diagrams, graphs, electrical schematics, and tables of data illustrate equipment used and results obtained. References and bibliographies are provided. The Proceedings are available at $1.50 per copy from Alloyd Research Corp., 202 Arsenal St., Watertown 72, Mass.

OTS REPORTS. A new Catalog of Technical Reports, *CTR-371*, "Computers, 1937-58," 10¢, lists all reports in the field of computers available to the public from the collection of the Office of Technical Services (OTS). A revision of the 1957 "Environmental Requirements Guide for Electronic Component Parts," published by the U. S. Department of Defense for use by Armed Forces technologists, is listed as *PB 131423R*, 50¢, and has been released to the public through the OTS. Technical papers and discussions of an Air Research and Development Command Symposium on Materials for Space Vehicles and Propulsion Systems has been released for public sale as *PB 151627*. It contains 502 pages, and its price is $7. All three of these reports may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C.

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District Executive Committees

District	Chairman (Vice-President, AIEE)	Secretary (District Secretary)	Chairman, District Committee on Student Activities	District Representative of Membership Committee	District Representative of Sections Committee	District Representative of Technical Operations Department
1 Empire	L. C. Holmes, Stromberg Carlson Co., 1400 N. Goodman St., Rochester 9, N. Y.	C. E. Gaylord, New York Telephone Co., Central Terminal, Buffalo 12, N. Y.	E. V. Kosso, Dept. of Elec. Engg., Syracuse University, Syracuse, N. Y.	R. E. Markle, IBM Corporation, Dept. 441, Route 17C, Glendale Drive, Endicott, N. Y.	L. F. Lewis, General Electric Co., 1 River Road, Schenectady 5, N. Y.	J. D. Stickler, General Electric Co., 625 Delaware Ave., P. O. Box 2021, Buffalo 3, N. Y.
2 Middle Eastern	D. L. Greene, Gilbert Associates, Inc., 525 Lancaster Ave., Reading, Pa.	F. S. Fehr, Metropolitan Edison Co., Reading, Pa.	H. M. Chandler, Jr., Dept. of Elec. Engg., Princeton University, Princeton, N. J.	E. T. Loane, Chesapeake & Potomac Telephone Co. of Maryland, 320 St. Paul Pl., Baltimore 2, Md.	W. W. Middleton, Bell Telephone Co. of Pa., 210 Pine St., Harrisburg, Pa.	R. L. Halberstadt, Bell Telephone Co. of Pa., 1500 Widener Bldg., Philadelphia, Pa.
3 Metropolitan New York	J. R. Kerner, Westinghouse Electric Corp., 40 Wall St., New York 5, N. Y.	R. T. Weil, Jr., Manhattan College, 4313 Manhattan Parkway at 242nd St., New York, N. Y.	R. R. Meola, Dept. of Elec. Engg., Newark College of Engineering, Newark, N. J.	W. G. Cheney, Westinghouse Electric Corp., 40 Wall St., New York 5, N. Y.	W. A. Clark, American Tel. & Tel. Co., 195 Broadway, New York, N. Y.	W. T. Rea, Bell Tel. Labs., Murray Hill, N. J.
4 South East	J. W. Davis, Southern Bell Tel. & Tel. Co., Room 540, Hurt Bldg., P. O. Box 2211, Atlanta 1, Ga.	E. G. Riley, McGraw-Edison Co., 361 E. Paces Ferry Rd., N. E., Atlanta, Ga.	E. W. Winkler, Dept. of Elec. Engg., North Carolina State Col., Raleigh, N. C.	B. V. Martin, Westinghouse Electric Corp., Box 1399, Charlotte 1, N. C.	R. H. Stevens, Florida Pr. & Lt. Co., Miami, Fla.	L. C. Moore, Westinghouse Electric Corp., Box 4808, Atlanta, Ga.
5 Great Lakes	R. B. Gear, Commonwealth Edison Co., 72 West Adams St., Chicago 90, Ill.	F. W. Bush, Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.	S. Freeman, Jr., Dept. of Elec. Engg., Purdue University, W. Lafayette, Ind.	D. F. Hayworth, Western Electric Co., Inc., Hawthorne Station, Chicago 23, Ill.	H. C. Brem, Allis-Chalmers Mfg. Co., Milwaukee, Wis.	G. L. Welch, Westinghouse Electric Corp., Merchandise Mart Plaza, Chicago 54, Ill.
6 North Central	M. H. Kight, Chief, Electric Branch, U. S. B. R., Denver Federal Ctr., Denver, Colo.	W. R. Wheeler, Dept. of Elec. Engg., Denver University, Denver, Colo.	A. E. Paige, Dept. of Elec. Engg., Denver University, Denver, Colo.	H. G. Hally, Iowa Power & Light Co., 823 Walnut St., Des Moines, Iowa	M. Mattison, Nebraska Public Pr. System, Columbus, Nebr.	W. L. Kelly, General Electric Co., 650 17th St., Denver, Colo.

7 Southwest	I. T. Monseth, Westinghouse Electric Corp., 411 N. 7th St., St. Louis 1, Mo.	O. T. Farry, Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.	P. E. Pfeiffer, Elec. Engg. Dept., Rice Institute, Houston 1, Tex.	W. C. Fowler, Sangamo Electric Co., 2424 Colonial Parkway, Fort Worth 9, Tex.	H. R. Vaughn, Westinghouse Electric Corp., 101 W. 11 St., Kansas City 6, Mo.	J. K. Howell, Westinghouse Electric Corp., 411 N. 7th St., St. Louis 1, Mo.
8 Pacific	G. T. Harness, San Fernando Valley State College, 18111 Nordhoff St., Northridge, Calif.	E. D. Barcus, Pacific Tel. & Tel. Co., 747 S. Olive St., Rm. 202, Los Angeles 55, Calif.	J. A. Peterson, Dept. of Elec. Engg., University of Santa Clara, Santa Clara, Calif.	W. E. MacMorran, Mountain States Tel. & Tel. Co., 16 W. McDowell Rd., Phoenix, Ariz.	W. Ridgway, General Electric Co., 235 Montgomery St., San Francisco, Calif.	C. A. Wells, Pacific Tel. & Tel. Co., 740 South Olive St., Los Angeles 55, Calif.
9 North West	J. M. Nelson, Lighting Dept., City of Seattle, 1015 3rd Ave., Seattle 4, Wash.	A. W. Moody, General Electric Co., P. O. Box 1858, Seattle 11, Wash.	S. A. Stone, Dept. of Elec. Engg., Oregon State College, Corvallis, Oreg.	L. C. Ford, General Electric Co., S. 162 Post St., Spokane, Wash.	M. M. Ewell, Westinghouse Electric Corp., 309 S. W. 6th Ave., Portland 4, Oreg.	W. J. Dowis, General Electric Co., 1603 Judson Ave., Richland, Wash.
10 Canada	Rene Dupuis, Quebec Hydro - Electric Comm., 107 Craig St., W., Montreal, Que.	R. A. Boyd, Quebec Hydro-Electric Comm., 107 Craig St., W., Montreal, Que.	Maurice Boisvert, Dept. of Elec. Engg., Laval University, Quebec, Que.	C. R. Thornton, Canadian Line Materials, 168 Charlotte St., Ottawa, Ont.	R. J. Brown, Mooney Electric Co., 213 Sterling Rd., Toronto, Ont.	F. L. French, Aluminum Union Ltd., Sun Life Bldg., Montreal, Que.
11 East Central	A. W. Rauth, Consumers Power Co., Trail & Jackson Sts., Jackson, Mich.	C. V. Carlson, Ohio Bell Telephone Co., 221 N. Front St., Rm. 102, Columbus, Ohio	C. F. Evert, Dept. of Elec. Engg., University of Cincinnati, Cincinnati, Ohio	W. E. Wier, Westinghouse Electric Corp., Lima, Ohio	R. E. Klokow, 2464 W. Elm St., Lima, Ohio	J. J. Fredrickson, General Electric Co., 120 W. Michigan Ave., Jackson, Mich.
12 North Eastern	F. S. Bacon, Jr., P. O. Box 58, Winchester, Mass.	L. J. Weed, Boston Edison Co., 1165 Massachusetts Ave., Dorchester 25, Mass.	D. E. Higginbotham, Dept. of Elec. Engg., Tufts University, Medford, Mass.	B. A. Cogbill, General Electric Co., 100 Woodlawn Ave., Pittsfield, Mass.	R. W. Hunt, Public Service Co. of New Hampshire, Keene, N. H.	D. C. Switzer, Hartford Electric Light Co., 266 Pearl St., Hartford, Conn.
13 South Central	C. P. Knost, Moloney Electric Co., 4018 Thalia St., New Orleans 25, La.	M. L. Hurstell, New Orleans Public Service, 317 Baronne St., New Orleans, La.	W. F. Gray, Dept. of Elec. Engg., University of Alabama, University, Ala.	W. A. Criley, Vanderbilt University, Box 1588, Station B, Nashville 4, Tenn.	W. C. Burnett, Southern Bell Tel. & Tel. Co., 1706 2nd Ave., N., Birmingham, Ala.	W. J. Miller, Dept. of Elec. Engg., University of Alabama, University, Ala.
14 Allegheny-Ohio Valley	W. H. Chase, Ohio Bell Telephone Co., 750 Huron Road, Cleveland 15, Ohio	K. L. Wheeler, Cleveland Elec. Illum. Co., 55 Public Square, Cleveland 1, Ohio	R. C. Gorham, Dept. of Elec. Engg., University of Pittsburgh, Pittsburgh, Pa.	O. C. Zingrebe, O. C. Zingrebe Co., 5700 Ridge Rd., Cleveland, Ohio	R. H. Hivley, Appalachian Pr. Co., Charleston, W. Va.	R. N. Wagner, Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa.

Section Officers

Name	District	When Organized	Chairman	Secretary	Secretary's Address
Akron	14	Aug. 12, '20	D. C. Emery	R. E. Moore	658 Arbutus Ct., Akron 7, Ohio
Alabama	13	May 22, '29	W. C. Turner	D. E. Straley	General Electric Co., Box 2602, Birmingham, Ala.
Arizona	8	Mar. 22, '41	F. M. Irish	A. B. Johnson	Westinghouse Electric Corp., P. O. Box 6144, Phoenix, Ariz.
Arkansas	7	Apr. 23, '47	K. J. Poole	H. Davenport	Bell Telephone Co., 900 W. 5 St., Little Rock, Ark.
Arrowhead	5	Apr. 23, '47	M. G. Alderink	H. Ledyard	Westinghouse Electric Corp., 408 Bradley Bldg., Duluth 2, Minn.
Baton Rouge	13	Feb. 3, '55	E. R. Felton	H. O. Bourque	Ethyl Corp., P. O. Box 341, Baton Rouge, La.
Beaumont	7	June 27, '45	E. A. Baumgartner	N. A. Lapham	3049 Lay Ave., Groves, Texas
Boston	12	Feb. 13, '03	P. H. Ware	W. F. Burt	NEGEA Service Corp., 10 Temple St., Cambridge 39, Mass.
Canton	14	Nov. 4, '47	J. E. Hamman	W. J. Spalding	767 E. Beech Rd., Alliance, Ohio
Central Illinois	5	June 28, '51	H. W. Griffith, Jr.	F. R. Heintze	Central Illinois Public Service Co., Illinois Bldg., Springfield, Ill.
Central Indiana	5	Jan. 12, '12	R. H. Jordan	F. S. English	5541 N. Drexel, Indianapolis, Ind.
Chicago	5	1893	F. A. Cox	W. T. Larner	Illinois Bell Telephone Co., 208 W. Washington St., Rm. 503, Chicago 6, Ill.
Cincinnati	11	June 30, '20	G. A. Koehler	G. T. Tashjian	5125 Leona Dr., Cincinnati 38, Ohio
Cleveland	14	Sept. 27, '07	E. C. Barnes	H. E. Caruso	Cleveland Electric Illuminating Co., Box 5000, Cleveland, Ohio
Columbus	11	Mar. 17, '22	E. O. Wolden	P. N. Curtis	1325 Haines Ave., Columbus 12, Ohio
Connecticut	12	Apr. 16, '21	Q. Q. Quinn	R. R. Shank	Dunham Laboratory of Elec. Engg., Yale University, New Haven, Conn.
Corpus Christi	7	Oct. 25, '51	J. D. deSilva	W. H. Fisher	255 Aberdeen St., Corpus Christi, Texas
Dayton	11	June 9, '43	C. A. Fisler	R. M. Kyvik	5259 Olentangy Dr. Dayton 31, Ohio
Delaware Bay	2	June 1, '52	R. J. Forman, Jr.	R. H. Lee	703 Greenwood Rd., Wilmington 6, Del.
Denver	6	May 18, '15	J. E. Martin	J. C. Livesay	Colorado Central Power Co., 3470 S. Bway, Englewood, Colo.
East Tennessee	13	Sept. 2, '36	F. Chambers	F. Atkinson	958 Signal Rd., Signal Mountain, Tenn.
El Paso	7	Mar. 7, '40	H. A. Wilson, Jr.	L. Backer	U. S. Bureau of Reclamation, 211 U. S. Court House, El Paso, Texas
Erie	1	Jan. 11, '18	T. J. Warrick	J. T. Duane	950 W. Sixth St., Erie, Pa.
Florida West Coast	4	Feb. 1, '52	R. E. Raymond	L. Ulm	Tampa Electric Co., Tampa, Fla.
Fort Wayne	5	Aug. 14, '08	M. J. Carroccio	J. Anderson, Jr.	5231 Riviera Dr., Fort Wayne, Ind.
Georgia	4	Jan. 14, '04	J. L. Bodeker	L. Curtis	Westinghouse Electric Corp., P. O. Box 4808, Atlanta, Ga.
Gulf Coast	13	Jan. 22, '53	L. S. Grandy	R. W. Hager	15 N. Ann St., Mobile, Ala.
Hamilton	10	May 1, '53	C. F. B. Dover	L. D. McConnell	Power Products Div., Canadian Westinghouse Co. Ltd., Hamilton, Ont.
Hawaii	8	June 24, '54	D. S. Bowman, Jr.	B. E. Miller	1797 A Star Route, Kaneohe, Oahu, Hawaii
Houston	7	Aug. 7, '28	A. F. Williams	W. T. Kittinger, Jr.	6207 Overdale, Houston 17, Texas

Idaho	9	Apr.	5,	'57	W. B. Mitchell	J. G. Hannum	729 Braemere, Boise, Idaho
Illinois Valley	5	June	30,	'45	R. P. Johnson	F. L. Jones	307 Howard, Robein Addition, Washington, Ill.
Iowa	6	June	29,	'29	P. M. Anderson	C. B. Feilmann	4101 Rose Hedge Dr., Des Moines, Iowa
Iowa-Illinois	5	June	24,	'54	L. L. Corbin	R. O. Lichtenstein	Industrial Engineering Equipment Co., 122 E. 4 St., Davenport, Iowa
Ithaca	1	Oct.	15,	'02	J. L. Cooney, Jr.	R. E. Markle	1 Edgewood Rd., Vestal, N. Y.
Jacksonville	4	Jan.	28,	'31	J. J. Berry	R. Heim	6620 New Castle Rd., Jacksonville, Fla.
Johnstown	14	Apr.	14,	'55	J. F. Worden	P. Pasternak	Pennsylvania Electric Co., 222 Levergood St., Johnstown, Pa.
Kansas City	7	Apr.	14,	'16	D. C. Williams	J. T. Tengdin	General Electric Co., 106 W. 14 St., Kansas City 5, Mo.
Lehigh Valley	2	Apr.	16,	'21	M. F. Rosol	J. K. McDonald	Pennsylvania Power & Light Co., 901 Hamilton St., Allentown, Pa.
Lima	11	June	24,	'54	G. H. Stearley	R. E. King, Jr.	2045 W. Wayne St., Lima, Ohio
Los Angeles	8	May	19,	'08	F. Foulon	L. L. Grandi	Dept. of Elec. Engg., University of California, Los Angeles 24, Calif.
Louisville	13	Oct.	15,	'26	R. Nalley	L. B. Jenkins, Jr.	220 N. 32 St., Louisville 12, Ky.
Lynn	12	Aug.	22,	'11	W. D. Bartlett	R. A. Pfuntner	General Electric Co., Rm. 368-ML, 40 Federal St., W. Lynn, Mass.
Madison	5	Jan.	8,	'09	R. H. Balliette	B. Johnson	521 Clifden Dr., Madison 5, Wis.
Maine	12	June	30,	'55	W. W. Turner	F. A. Smith	New England Tel. & Tel. Co., Box 1317, Portland, Maine
Mansfield	11	Mar.	6,	'39	C. Curran	H. L. Kay	Power Equipment Co., Galion, Ohio
Maryland	2	Dec.	16,	'04	G. P. Stout	W. A. Laning	54 Burkshire Rd., Towson 4, Md.
Memphis	13	May	22,	'30	W. L. Wood, Jr.	L. E. Cox	Memphis Lt., Gas & Water Div., Box 388, Memphis, Tenn.
Mexico	7	June	29,	'22	F. Aubert B.	J. Colon	Emerson No. 118, Mexico 5, D.F., Mexico
Miami	4	Feb.	3,	'49	G. F. MacNichol	A. C. Fyler	3159 Commodore Plaza, Miami 33, Fla.
Michigan	11	Jan.	15,	'11	B. H. Schneider	J. J. Fredrickson	General Electric Co., 120 W. Michigan Ave, Jackson, Mich.
Milwaukee	5	Feb.	11,	'10	W. R. Ibach	R. E. Horn	Allis-Chalmers Mfg. Co., 1126 S. 70 St., Milwaukee 14, Wis.
Minnesota	5	Apr.	7,	'02	H. W. Ecker	E. C. Davidson	Westinghouse Electric Corp., 2303 N. E. Kennedy, Minneapolis 18, Minn.
Mississippi	13	June	28,	'51	J. D. Phillips	J. M. Hemphill	1038 Matthews, Jackson, Miss.
Montana	9	June	24,	'31	C. R. Beitman	T. Gerlach	533 Park Lane, Billings, Mont.
Montreal	10	Apr.	16,	'43	P. E. Rose	L. Swift	Canadian Hoosier Engrg. Co. Ltd., 340 Cremazie Blvd. W., Montreal, Que.
Nashville	13	June	28,	'51	A. T. Kanaday	F. F. Elliott	Nashville Electric Service, 1214 Church St., Nashville 3, Tenn.
Nebraska	6	Jan.	21,	'25	P. T. Baird	R. W. Shaw	Omaha Public Power Dist., 4 Fl., Electric Bldg., Omaha, Nebr.
New Hampshire	12	Sept.	3,	'53	H. J. Ellis	R. A. Nichols	Public Service Co. of N. H., 1087 Elm St., Manchester, N. H.
New Orleans	13	Dec.	8,	'33	J. A. Cronvich	S. Cambias, Jr.	1606 Charlton Dr., New Orleans, La.
New York	3	Dec.	10,	'19	W. G. Vieth	B. B. Jordan	Western Electric Co., Kearny, N. J.
Niagara Frontier	1	Feb.	10,	'25	A. Fini	E. G. Ball	351 Okell St., Buffalo 20, N. Y.
Niagara International	10	Aug.	5,	'48	A. M. Bizzell	W. R. Pfaff	St. Catherines Public Utilities Comm., St. Catherines, Ont.
North Carolina	4	Mar.	21,	'29	M. J. Mulhern	F. K. Vance	Western Electric Co., Lexington Rd. Plant, Dept. 7710, Winston-Salem, N. C.
North Texas	7	May	18,	'28	J. L. Sandlin	H. L. Medlin	Southwestern Bell Telephone Co., Telephone Bldg., Dallas 1, Texas
Northeastern Michigan	11	Feb.	2,	'50	L. G. Clemence	A. G. Rogers	320 E. Vienna St., Clio, Mich.
Northeastern Wisconsin	5	Feb.	4,	'58	R. Schmitz	C. A. Lins	Westinghouse Electric Corp., Box 206, Appleton, Wis.
Northern New Mexico	7	Jan.	25,	'51	J. H. Hays	D. H. Pollard	Westinghouse Electric Corp., Albuquerque, N. Mex.
Oak Ridge	13	Feb.	1950		P. Rubel	E. R. Sullivan, Jr.	117 Valparaiso Rd., Oak Ridge, Tenn.
Ohio Valley	14	June	28,	'51	J. H. Reeves	R. W. Hinshaw	133 Kings Hwy., Huntington, W. Va.
Oklahoma City	7	Feb.	16,	'22	J. S. Wyble	H. J. McMains	Southwestern Bell Tel. Co., 210 N.W. Sixth St., Oklahoma City 2, Okla.
Ottawa	10	June	25,	'49	R. P. Gaylard	D. G. Donaldson	Ottawa Hydro-Electric Comm., Albion & Kitchener Rd., Ottawa, Ont.
Panhandle Plains	7	June	12,	'47	S. S. Rutledge	J. H. Evans	Southwestern Public Service Co., Amarillo, Texas
Philadelphia	2	Feb.	18,	'03	R. S. Hewett	W. O. Mascaro	Atlantic Refining Co., 260 S. Broad St., Philadelphia 1, Pa.
Pittsburgh	14	Oct.	3,	'02	L. W. Tarn	J. F. Calvert	Dept. of Elec. Engg., University of Pittsburgh, Pittsburgh, Pa.
Pittsfield	12	Mar.	25,	'04	J. O. Sweeny	J. Church	General Electric Co., Bldg. 16-302,100 Woodlawn Ave., Pittsfield, Mass.
Portland	9	May	18,	'09	C. C. Diemond	P. M. Sweeney	Pacific Tel. & Tel. Co., 509 S.W. Oak St., Portland 4, Oreg.
Providence	12	Mar.	12,	'20	J. K. Andrews	A. L. Marshall	21 Woburn Rd., Rumford 16, R. I.
Richland	9	Apr.	23,	'48	A. A. Maxwell	W. J. Ferguson	Rt. 1, Benton City, Wash.
Ridgway	14	June	26,	'52	P. S. Johrde	H. C. Bicknell	Elliott Co., Ridgway, Pa.
Rochester	1	Oct.	9,	'14	H. L. Foote	R. W. McCarty	Eastman Kodak Co., Kodak Park, Bldg. 23, Rochester 4, N. Y.
Rock River Valley	5	Apr.	23,	'47	M. H. Shatswell, Jr.	J. E. McAllister	General Electric Co., 110 S. First St., Rockford, Ill.
Sacramento	8	June	15,	'50	J. E. Chester	M. Limerick	5310 Monterey Way, Sacramento, Calif.
St. Louis	7	Jan.	14,	'03	W. J. Roa, Jr.	C. H. Zurheide	Smith-Hanlon-Zurheide-Levy, Inc., 4010 Lindell Blvd., St. Louis 8, Mo.
St. Maurice Valley	10	June	24,	'54	G. H. Cook	K. E. Sorensen	2624 Marie Leneuf, Trois Rivieres, Que.
San Diego	8	Jan.	18,	'39	J. W. Crooks, Jr.	R. A. Kinslow	525 E St., Rm. 216, San Diego, Calif.
San Francisco	8	Dec.	23,	'04	R. H. Miller	R. E. Grady	353 Sacramento St., San Francisco, Calif.
Savannah	4	Oct.	14,	'54	C. D. Anderson	J. B. Henley, Jr.	R. F. S. #6, Wymberly, Savannah, Ga.
Schenectady	1	Jan.	26,	'03	J. C. White	J. J. W. Brown	General Electric Co., 1 River Rd., Schenectady, N. Y.
Seattle	9	Jan.	19,	'04	G. D. Jorgensen	S. J. McDermott	Pacific Tel. & Tel. Co., 1327 Exchange Bldg., Seattle 4, Wash.
Sharon	14	Dec.	11,	'25	T. R. Specht	H. F. Barsun	Westinghouse Electric Corp., 469 Sharpsville Ave., Sharon, Pa.
Shreveport	7	June	12,	'47	P. L. Gunn	G. C. Hengy	George C. Hengy Co., 228 N. Market St., Shreveport La.
South Bend	5	Feb.	26,	'41	D. W. Comstock	E. LaSalle	4123 Sunset Pl., South Bend, Ind.
South Carolina	4	Mar.	2,	'40	F. J. Fishburne	J. R. Dickson	Westinghouse Electric Corp., Charleston, S. C.
South Texas	7	May	23,	'30	E. H. Soderberg	R. L. Hancock	2619 W. 49 St., Austin, Texas
Spokane	9	Feb.	14,	'13	W. A. Morgan	H. E. Hattrup	Electrical Engg. Dept., Univ. of Idaho, Moscow, Idaho

Springfield	12	June 29,	'22	S. H. Lull	S. H. Law	33 Hanward Hill, E. Longmeadow, Mass.
Susquehanna	2	June 18,	'53	W. W. Middleton	K. M. Hammell	Aircraft-Marine Prods., Inc., 2100 Paxton St., Harrisburg, Pa.
Syracuse	1	Aug. 12,	'20	R. A. Nevin	E. G. Samolis	Allis-Chalmers Mfg. Co., 472 S. Salina St., Syracuse, N. Y.
Toledo	11	June 3,	'07	H. E. Kohler	L. E. Smith	2504 Aldringham Rd., Toledo 6, Ohio
Toronto	10	Sept. 30,	'03	V. B. Ross	G. M. Fraser	G. M. Fraser, Ltd., 1554 Yonge St., Toronto, Ont.
Tulsa	7	Oct. 1,	'37	J. C. Wells	F. N. Wightman	Westinghouse Electric Corp., 703 Enterprise Bldg., Tulsa, Okla.
Utah	9	Mar. 9,	'17	F. C. Bates	C. R. Lufkin	Box 779, Salt Lake City, Utah
Vancouver	9	Aug. 22,	'11	R. C. A. Stewart	E. A. Harvey	Federal Pacific Electric of Canada, 22 E. 5th Ave., Vancouver, B. C.
Victoria	9	Oct. 5,	'56	P. J. Croft	F. J. Bennett	B. C. Electric Co., Ltd., 820 Pandora Ave., Victoria, B. C.
Virginia	4	May 19,	'22	A. S. Hadfield	Mrs. K. Joyner	4403 Victoria Blvd., Hampton, Va.
Virginia Mountain	4	June 23,	'49	G. R. Meek	G. C. Barnes, Jr.	Virginia Polytechnic Inst., Blacksburg, Va.
Washington	2	Apr. 9,	'03	W. M. Edmunds	I. L. Cooter	Kurtz Rd., Box 184, Rt. 3, McLean, Va.
West Michigan	11	June 24,	'54	S. R. Van Antwerp	W. Sherwood	Consumers Power Co., 129-131 Pearl St., N. W., Grand Rapids 2, Mich.
West Virginia	14	Apr. 9,	'40	L. M. Roth	M. H. W. Illing	Union Carbide Chem. Co., Bldg. 32, Rm. 625, South Charleston, W. Va.
Wichita	7	Sept. 16,	'37	J. H. Jenkins	E. L. Clark	Beech Aircraft Co., 9707 E. Central, Wichita, Kan.
Worcester	12	Feb. 18,	'20	J. W. Smith	J. L. Kelley	Westinghouse Electric Corp., 507 Main St., Worcester 8, Mass.

Total Sections 112

Subsection Officers

Name	District	Chairman	Secretary	Secretary's Address
Adirondack (Schenectady Section)	1	J. D. Stacy	C. R. Craig	General Electric Co., Lower John St., Hudson Falls, N. Y.
Alaska (Seattle Section)	9	H. P. Lang	C. F. Malm	Line Material Industries, 4502 Lois Dr., Anchorage, Alaska
Atlantic City Division (Philadelphia Section)	2	R. C. R. Schulze	L. J. Curran	318 45 Pl., Sea Isle City, N. J.
Billings (Montana Section)	9	G. A. Lewis	F. Dashen	802 Parkhill Dr., Billings, Mont.
Binghamton Area (Ithaca Section)	1	E. A. Madlon	R. B. Mackenzie	96 Gilmore Ave., Binghamton, N. Y.
Black Hills (Denver Section)	6	C. K. Hale		
Blue Ridge (Virginia Section)	4	D. B. Schneider	H. S. Landes	Deerpath Rd. Bellair, Charlottesville, Va.
Boulder City (Los Angeles Section)	8	R. E. Bellis	D. O. Towne	1101 Avenue G, Boulder City, Nev.
Butte (Montana Section)	9	R. J. Labrie	J. M. McCarvel	Westinghouse Electric Corp., 1 E. Bway, Butte, Mont.
Cedar Valley (Iowa-Illinois Section)	5	A. G. Best	J. K. Hicks	1530 Henderson Dr., Marion, Iowa
Central Florida (Florida West Coast Section)	4	A. J. Faraon	R. R. Rowell	232 Hillcrest Ave., Orlando, Fla.
Central Savannah River (South Carolina Section)	4	H. S. Sanders	W. O. Gibson	911 Holiday Dr., N. Augusta, S. C.
Central Texas (North Texas Section)	7	W. S. Robson	R. J. Sayger	Brazos Elec. Power Coop., Inc., 2404-12 La Salle Ave., Waco, Texas
Centre County (Pittsburgh Section)	14	H. M. Jensen	E. F. Golla	1173 Orr Ave., Kittanning, Pa.
Charleston (South Carolina Section)	4	W. S. Anderson	S. R. Hall, Jr.	717 Adluth St., Mt. Pleasant, S. C.
Charlotte (North Carolina Section)	4	W. T. Edwards	O. T. Kirby	General Electric Co., Box 1969, Charlotte 1, N. C.
Chillicothe (Columbus Section)	11	L. Ruegsegger	H. G. Johnson	50 Barker Rd., Lake White, Waverly, Ohio
Columbia (South Carolina Section)	4	R. P. Teeple	B. F. Holland	South Carolina Elec. & Gas Co., P. O. Box 390, Columbia, S. C.
Eastern Division (St. Louis Section)	7	C. L. Eletson	E. Bacus	729 E. 7 St., Alton, Ill.
Eastern North Carolina (North Carolina Section)	4	T. D. Barnes	R. N. Brigham	Wright Machinery Co., Calvin and Holloway Sts., Durham, N. C.
Eastern Shore (Maryland)	2	C. E. Moore	G. L. Mears	Box 593, Denton, Md.
Eugene (Portland Section)	9	R. R. Michael	K. A. Andrew	General Electric Co., P. O. Box 352, Eugene, Oreg.
Evansville (Central Indiana Section)	5	R. H. Schnakenburg	O. V. Herendeen	I. B. M. Corp., 423 Main St., Evansville, Ind.
Fort Worth (North Texas Section)	7	E. D. Button	L. F. Fikar	Texas Electric Service Co., P. O. Box 970, Ft. Worth, Texas
Freeport (Houston Section)	7	G. B. Dorroh	W. A. Bollen	401 Winding Way, Lake Jackson, Texas
Fresno (San Francisco Section)	8	J. G. Floyd	E. L. Swords	Pacific Gas & Electric Co., 1401 Fulton St., Rm. 607, Fresno 21, Calif.
Guelph (Hamilton Section)	10	A. G. Stacey	E. H. Tracy	23 McDonald Ave., Guelph, Ont.
Hampton Roads (Virginia Section)	4	J. E. Bowman	D. D. Smith	38 Kenwood Dr., Hampton, Va.
Helena (Montana)	9	D. A. Johnson	R. A. Young	1407 Jerome Pl., Helena, Mont.
Hudson Valley Division (New York Section)	3	G. H. Lugert	W. J. Fitzgerald	I. B. M. Corp., Poughkeepsie, N. Y.
Huntsville (East Tennessee Section)	13		G. Daussman	1910 Colice Road, Huntsville, Ala.
Jackson (Memphis Section)	13	A. Fail	W. Williams	Box 477, Springfield, Tenn.
Lake Charles (Beaumont Section)	7	R. A. Cox	P. Landry	Olin Mathieson Chemical Corp., 130 W. Lee, Maplewood, La.
Lexington (Louisville Section)	13	C. T. Maney	K. Barnett	Kentucky Utilities Co., S. 120 Limestone St., Lexington, Ky
London (Hamilton Section)	10	T. E. Smith	G. S. Duffus	Route 5, London, Ont.
Los Alamos-Santa Fe (Northern New Mexico Section)	7	E. O. Swickard, Jr.	D. E. Elliot	2346 C 45th, Los Alamos, N. Mex.
Marion (Fort Wayne Section)	5	W. Beasley	O. Willis	2103 W. 8 St., Marion, Ind.
Medford (Portland Section)	9	R. Denyer	R. M. Johnson	Westinghouse Electric Corp., Box 1308, Medford, Oreg.
Merrimack Valley (Lynn Section)	12	R. E. Sherman	R. L. Case	Bell Telephone Labs., 1600 Osgood St., N. Andover, Mass.
Mid-State (North Carolina Section)	4	E. L. Getchell	H. Chafin	Colter & Chappell Elec. Co., 2101 Sunnyside Ave., Winston-Salem, N. C.
Monroe (Shreveport Section)	7	J. H. Hebert	I. T. Landhy	203 Auburn Ave., Monroe, La.
Monterrey (Mexico Section)	7			
Montgomery (Alabama Section)	13	M. J. Harris, Jr.	H. A. McClendon	1059 Lynwood Dr., Montgomery 6, Ala.
Muscle Shoals (East Tennessee Section)	13	R. L. Lee	B. R. Henry	Tennessee Court Apts., Florence, Ala.

New Jersey Division (New York Section)	3	H. W. Lensner	J. F. Schwanhausser	29 Fairview Ave., Summit, N. J.
New London (Connecticut Section)	12	H. C. Hemond	G. Rodgers	Elec. Engg. Dept., U. S. Coast Guard Academy, New London, Conn.
Newark (Columbus Section)	11	F. W. Atkinson	B. T. Butler	249 Central, Newark, Ohio
Northwest Arkansas (Arkansas Section)	7	D. Conger	L. Howell	121 S. Duncan St., Fayetteville, Ark.
Orange County (Los Angeles)	8	W. J. H. Thoele	W. J. Hawkins	2244 N. Virazon Dr., La Habra, Calif.
Palm Beach (Miami Section)	4	J. P. Jenkins	E. M. Chabot	107 Gregory Pl., W. Palm Beach, Fla.
Panama City (Gulf Coast)	13	R. E. Lealman, Jr.	J. F. Conner	P. O. Box 783, Panama City, Fla.
Piedmont (South Carolina Section)	4	W. W. Pruitt	F. M. Watkins	P. O. Box 960, Greenville, S. C.
Quebec (Montreal Section)	10	I. I. Inculet	V. Le Guerrier	Quebec Power Co., 399 St. Joseph St. E., Quebec 2, Que.
Racine-Kenosha (Milwaukee Section)	5	L. T. Christenson	J. Herbst	Dynamatic Div., Eaton Mfg. Co., 3307 14 St., Kenosha, Wis.
Red River Valley Div. (Minnesota Section)	5	J. J. Malone	C. C. Collins	2110 N. 9½ St. Fargo, N. Dak.
Reno (San Francisco Section)	8	E. V. Gelmstedt	R. M. Huggard	344 W. 11 St., Reno, Nev.
Richmond (Virginia Section)	4	E. J. Szczebak	G. R. Lufsey	Virginia Elec. & Pr. Co., P. O. Box 1194, Richmond 9, Va.
Riverside-San Bernardino (Los Angeles Section)	8	A. F. Ayres	J. G. Hart, Jr.	2754 Woodbine St., Riverside, Calif.
Rome (Georgia Section)	4	C. C. Rutledge	B. F. Allen	General Electric Co., Bldg. #1-237, Redmond Circle, Rome, Ga.
St. Lawrence International (Syracuse Section)	1	G. W. Reed	P. D. Tuttle	25 Homecroft Court, Massena, N. Y.
San Joaquin (Sacramento Section)	8	W. L. Marre	H. W. Thomson	1422 Coolidge Ave., Tracy, Calif.
Santa Clara Valley (San Francisco Section)	8	H. R. McLaughlin	O. R. Blair	Westinghouse Electric Corp., Sunnyvale, Calif.
Scioto Valley (Ohio Valley Section)	14	W. E. Linville	C. J. Gilmer	Goodyear Atomic Corp., Portsmouth, Ohio
Shasta (San Francisco Section)	8	W. R. Hampton	E. F. Weller	1580 Chestnut St., Redding, Calif.
Siouxland (Iowa Section)	6	R. W. Lundquist	M. F. Gardner	2536 S. Paxton St., Sioux City, Iowa
Southern Idaho (Idaho Section)	9	M. P. Coover	W. M. Soule	2145 Avocet Dr., Idaho Falls, Idaho
Tacoma (Seattle Section)	9	R. M. Boyles	T. J. Cross	260 S. 5th, Tacoma, Wash.
Tullahoma (East Tennessee Section)	13	R. W. Kaisner	T. V. Brewer	210 Stone Blvd., Tullahoma, Tenn.
Upper East Tennessee (East Tennessee Section)	13	J. Robinson	G. C. Montgomery	Tennessee Eastman Co., Kingsport, Tenn.
Upper Monongahela (Pittsburgh Section)	14	E. C. Jones	M. J. Smith	Dept. of Elec. Engg., West Virginia University, Morgantown, W. Va.
Vermont (Pittsfield Section)	12	H. A. Van Dine, Jr.	G. H. Howland	20 High St., Rutland, Vt.
Victoria-Port Lavaca (Corpus Christi Section)	7	J. H. Wieting	J. W. Fish	Southwestern Bell Telephone Co., 403 N. Main St., Victoria, Texas
Walla Walla (Richland Section)	9	W. E. Triplett	R. L. Earnheart	Box 197, McNary, Oreg.
Wenatchee (Spokane Section)	9	V. J. Fitzgerald	G. H. Edwards	Chelan P.V.D. #1, P. O. Box 1231, Wenatchee, Wash.
West Central Texas (North Texas Section)	7	R. D. Strong	G. E. Compton	General Electric Co., 220 Pender Bldg., Abilene, Texas
Western North Carolina (North Carolina Section)	4	J. R. Stephens	K. A. Arledge	Duke Power Co., Hendersonville, N. C.
Zanesville (Columbus Section)	11	F. Hatfield	W. G. Mauk	2105 Tannehill St., Zanesville, O.

Total Subsections 77

Student Branch Counselors

Name, Location, Date Originated	Counselor District (Member of Faculty)
Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio (11-15-58)	11..T. L. Regulinski
*Akron, University of, Akron, Ohio (10-15-26)	14..K. F. Sibila
Alabama Polytechnic Institute, Auburn, Ala. (11-10-16)	13..A. T. Sprague, Jr.
*Alabama, University of, University, Ala. (12-11-14)	13..W. F. Gray
*Alaska, University of, College, Alaska (6-29-56)	9..R. P. Merritt
*Alberta, University of, Edmonton, Alta. (5-26-39)	10..R. E. Phillips
†Arizona State College, Tempe, Ariz. (2-5-58)	8..R. L. Riese
*Arizona, University of, Tucson, Ariz. (2-12-21)	8..R. L. Walker
*Arkansas, University of, Fayetteville, Ark. (3-25-04)	7..Bryan Webb, Jr.
†Bradford Durfee College of Technology, Fall River, Mass. (2-2-56)	12..B. B. Hardy
†Bradley University, Peoria, Ill. (6-23-58)	5..Philip Weinberg
†Brigham Young University, Provo, Utah (12-22-58)	9..D. J. Monson
*British Columbia, University of, Vancouver, B. C. (6-25-30)	9..L. R. Kersey
*Brooklyn, Polytechnic Institute of, Brooklyn, N. Y. (Day) (1-14-16)	3..C. W. Lawrence
*Brooklyn, Polytechnic Institute of, Brooklyn, N. Y. (Evening)	3
*Brown University, Providence, R. I. (8-7-34)	12..P. A. Doyle
*Bucknell University, Lewisburg, Pa. (5-17-10)	2..H. C. Webb
†Buffalo, University of, Buffalo, N. Y. (4-3-56)	1..F. P. Fischer
*California Institute of Technology, Pasadena, Calif. (10-14-10)	8..F. J. Mullin
†California State Polytechnic College, San Luis Obispo, Calif. (2-2-56)	8..W. R. Anderson
*California, University of, Berkeley, Calif. (2-9-12)	8..A. R. Bergen
*Carnegie Institute of Technology, Pittsburgh, Pa. (5-18-15)	14..A. G. Milnes
*Case Institute of Technology, Cleveland, Ohio (11-12-20)	14..R. D. Chenoweth
*Catholic University of America, Washington, D. C. (12-14-23)	2..J. C. Michalowicz
†Christian Brothers College, Memphis, Tenn. (5-28-57)	13..Lawrence Philip
*Cincinnati, University of, Cincinnati, Ohio (4-10-08)	11..C. F. Evert, Jr.
*Clarkson College of Technology, Potsdam, N. Y. (12-10-15)	1..R. G. Gentile
*Clemson A & M College, Clemson, S. C. (11-8-12)	4..H. V. Poe
*Colorado State University, Fort Collins, Colo. (2-11-10)	6..J. E. Dean
*Colorado, University of, Boulder, Colo. (12-16-04)	6..G. E. Gless
*Columbia University, New York, N. Y. (1-26-37)	3..Peter Mauzey
*Connecticut, University of, Storrs, Conn. (1-30-41)	12..H. M. Lucal
*Cooper Union, New York, N. Y. (2-16-21)	3..Sidney Epstein
*Cornell University, Ithaca, N. Y. (10-18-28)	1..N. H. Bryant
*Dayton, University of, Dayton, Ohio (4-23-55)	11..Adrian Morgan
*Delaware, University of, Newark, Del. (1-29-42)	2..D. M. Robinson
*Denver, University of, Denver, Colo. (2-15-23)	6..A. E. Paige
*Detroit, University of, Detroit, Mich. (5-18-28)	11..R. W. Ahlquist
*Drexel Institute of Technology, Philadelphia, Pa. (4-11-19)	2..F. C. Powell
Duke University, Durham, N. C. (2-10-27)	4..J. L. Artley, Jr.
Fenn College, Cleveland, Ohio (2-3-49)	14..R. W. Schindler
*Florida, University of, Gainesville, Fla. (2-7-24)	4..O. I. Elgerd
†Gannon College, Erie, Pa. (6-30-55)	1..L. R. Moskowitz
*George Washington University, Washington, D. C. (12-6-32)	2..N. B. Ames
Georgia Institute of Technology, Atlanta, Ga. (6-25-14)	4..E. R. Weston
†Houston, University of, Houston, Texas (4-14-53)	7..W. T. Kittinger

*Howard University, Washington, D. C. (10-20-49) 2..E. R. Welch
Idaho, University of, Moscow, Idaho (6-25-14) . 9..Paul Mann
Illinois Institute of Technology, Chicago, Ill. (2-26-04) ..... 5..A. C. Todd
*Illinois, University of, Urbana, Ill. (1-28-31) .. 5..P. R. Egbert
Chicago Division, Chicago, Ill. ..... 5..
*Iowa State College, Ames, Iowa (4-15-05) ..... 6..R. F. Schauer
Iowa, University of, Iowa City, Iowa (5-18-09) . 5..E. B. Kurtz
*Johns Hopkins University, Baltimore, Md. (1-21-35) ..... 2..Thorstein Larsen
Kansas State College, Manhattan, Kans. (1-16-09) 7..M. C. Cottom
*Kansas, University of, Lawrence, Kans. (3-18-08) 7..C. H. Thomas
Kentucky, University of, Lexington, Ky. (10-14-10) .....13..L. N. Black
*Lafayette College, Easton, Pa. (4-5-12) ..... 2..F. W. Smith
Lamar State College of Technology, Beaumont, Texas (4-14-55) ..... 7..L. E. Bohrer
Laval University, Quebec, Que. (6-26-52) ..... 10..Maurice Boisvert
*Lehigh University, Bethlehem, Pa. (10-15-02) .. 2..
*Louisiana Polytechnic Institute, Ruston, La. (2-3-49) ..... 7..D. L. Johnson
*Louisiana State University, Baton Rouge, La. (8-10-26) .....13..M. B. Reed
*Louisville, University of, Louisville, Ky. (4-6-28) 13..L. B. Jenkins
*Maine, University of, Orono, Maine (12-26-06) 12..K. L. Parsons'
*Manhattan College, New York, N. Y. (1-30-41) . 3..R. T. Weil, Jr.
*Marquette University, Milwaukee, Wis. (5-19-22) 5..Stanley Krupnik Jr.
*Maryland, University of, College Park, Md. (3-9-36) ..... 2..H. C. Jones
*Massachusetts Institute of Technology, Cambridge, Mass. (4-13-17) .....12..L. A. Gould
*Massachusetts, University of, Amherst, Mass. (10-26-50) .....12..F. H. Edwards
†Merrimack College, N. Andover, Mass. (12-10-57) .....12..J. F. Sullivan
†Miami, University of, Coral Gables, Fla. (6-29-56) ..... 4..F. B. Lucas
*Michigan College of Mining and Technology, Houghton, Mich. (6-25-29) ..... 5..V. O. York
*Michigan State University, East Lansing, Mich. (3-15-18) .....11..Ira Baccus
*Michigan, University of, Ann Arbor, Mich. (3-25-04) .....11..R. F. Mosher
Milwaukee School of Engineering, Milwaukee, Wis. (8-12-19) ..... 5..R. J. Ungrodt
*Minnesota, University of, Minneapolis, Minn. (5-16-16) ..... 5..P. A. Cartwright
Mississippi State College, State College, Miss. (12-10-26) .....13..D. F. Fitzgerald
*Missouri School of Mines and Metallurgy, Rolla, Mo. (3-13-25) ..... 7..J. H. Johnson
*Missouri, University of, Columbia, Mo. (1-10-03) 7..J. C. Hogan
*Montana State College, Bozeman, Mont. (5-21-07) ..... 9..R. F. Durnford
*Nebraska, University of, Lincoln, Nebr. (4-10-08) 6..W. C. Robison
*Nevada, University of, Reno, Nev. (5-19-22) .. 8..G. H. Clark
Newark College of Engineering, Newark, N. J. (10-15-26) ..... 3..R. R. Meola
†New Bedford Institute of Technology, New Bedford, Mass. (2-2-56) .....12..H. S. Hayre
*New Hampshire, University of, Durham, N. H. (8-10-26) .....12..Donald Melvin
*New Mexico State University, State College, N. Mex. (12-16-38) ..... 7..C. D. Crosno
*New Mexico, University of, Albuquerque, N. Mex. ..... 7..R. W. Tapy
*New York, College of the City of, New York, N. Y. (3-11-21) ..... 3..W. T. Hunt
*New York University, New York, N. Y. (Day) . (12-5-24) ..... 3..Harlan Perlis
*New York University, New York, N. Y. (Evening) ..... 3..Harlan Perlis
*North Carolina State University, Raleigh, N. C. (2-11-10) ..... 4..E. W. Winkler
*North Dakota State College, Fargo, N. Dak. (5-22-29) ..... 5..L. S. Van Slyck
*North Dakota, University of, Grand Forks, N. Dak. (2-17-15) ..... 5..J. D. Dixon
*Northeastern University, Boston, Mass. (12-8-22) .....12..J. E. Trott
*Northwestern University, Evanston, Ill. (1-26-37) 5..R. W. Jones
*Norwich University, Northfield, Vt. (5-24-40) ..12..P. M. Seal
*Notre Dame, University of, Notre Dame, Ind. (2-19-19) ..... 5..L. F. Stauder
*Ohio Northern University, Ada, Ohio (2-9-12) 11..Carroll Alden
*Ohio State University, Columbus, Ohio (12-20-02) .....11..F. C. Weimer
*Ohio University, Athens, Ohio (2-9-26) .....11..G. Smith
*Oklahoma State University, Stillwater, Okla. (10-13-11) ..... 7..T. B. Thompson
*Oklahoma, University of, Norman, Okla. (10-11-12) ..... 7..D. L. Hill
Oregon State College, Corvallis, Oreg. (3-28-08) 9..S. A. Stone
*Pennsylvania State University, University Park, Pa. (12-20-02) .....14..R. E. Armington
*Pennsylvania, University of, Philadelphia, Pa. (4-11-19) ..... 2..R. S. Berkowitz
Pittsburgh, University of, Pittsburgh, Pa. (2-26-14) .....14..R. C. Gorham
*Pratt Institute, Brooklyn, N. Y. (12-3-29) .... 3..Louis Jacobs
*Princeton University, Princeton, N. J. (8-10-26) 2..J. B. Thomas
Puerto Rico, University of, Mayaguez, P. R. (12-6-32) ..... 3..O. Porrata-Doria
*Purdue University, Lafayette, Ind. (1-26-03) .. 5..Stephen Freeman, Jr.
*Rensselaer Polytechnic Institute, Troy, N. Y. (11-12-09) ..... 1..L. P. Winsor
*Rhode Island, University of, Kingston, R. I. (3-14-24) .....12..J. F. Grove
*Rice Institute, Houston, Texas (1-28-31) ..... 7..P. E. Pfeiffer
*Rose Polytechnic Institute, Terre Haute, Ind. (11-10-11) ..... 5..M. P. Danner
*Rutgers University, New Brunswick, N. J. (11-17-21) ..... 3..J. R. Rankin, Jr.
Saint Louis University, St. Louis, Mo. (1-22-53) 7..
†San Jose State College, San Jose, Calif. (12-23-58) ..... 8..E. C. Glover
*Santa Clara, University of, Santa Clara, Calif. (10-15-26) ..... 8..J. A. Peterson
†Seattle University, Seattle, Wash. (2-2-56) ..... 9..D. K. Reynolds
*South Carolina, University of, Columbia, S. C. . (6-27-28) ..... 4..S. T. Moseley
South Dakota School of Mines and Technology, Rapid City, S. Dak. (1-1-25) ..... 6..W. A. Hixson
*South Dakota State College, Brookings, S. Dak. (5-22-23) ..... 6..Kenneth Lindley
*Southern California, University of, Los Angeles, Calif. (8-16-21) ..... 8..R. S. Macmillan
*Southern Methodist University, Dallas, Texas (5-22-29) ..... 7..F. W. Tatum
Southwestern Louisiana Institute, Lafayette, La. (3-13-58) .....13..A. W. Grove
*Stanford University, Stanford, Calif. (12-13-07) 8..Rudolf Panholzer
*Stevens Institute of Technology, Hoboken, N. J. (12-11-25) ..... 3..H. W. Phair
*Swarthmore College, Swarthmore, Pa. (5-20-21) 2..Carl Barus
*Syracuse University, Syracuse, N. Y. (2-24-05) .. 1..E. V. Kosso
†Tennessee Polytechnic Institute, Cookeville, Tenn. (4-14-55) .....13..A. L. Duke
Tennessee, University of, Knoxville, Tenn. (5-19-23) .....13..
*Texas, A & M College of, College Station, Texas (11-12-09) ..... 7..W. P. Worley
†Texas College of Arts and Industries, Kingsville, Texas (4-14-55) ..... 7..Emerson Korges
*Texas Technological College, Lubbock, Texas (12-3-29) ..... 7..T. B. Stenis
*Texas, University of, Austin, Texas (2-14-08) .. 7..R. R. Krezdorn
Texas Western College, El Paso, Texas ..... 7..F. A. Decker
*Toledo, University of, Toledo, Ohio (1-25-51) ..11..Donald Ewing
*Toronto, University of, Toronto, Ont., Canada (8-1-46) .....10..J. E. Reid
*Tufts College, Medford, Mass. (1-21-35) .....12..D. E. Higginbotham
*Tulane University, New Orleans, La. (1-26-37)13..G. W. Webb
*Union College, Schenectady, N. Y. (12-7-34) .. 1..D. A. Buddenhagen
United States Naval Academy, Annapolis, Md. (1-25-51) ..... 2..
United States Naval Post Graduate School, Monterey, Calif. (2-2-56) ..... 8..O. H. Polk
Utah State University, Logan, Utah (3-17-58) .. 9..B. O. Watkins
*Utah, University of, Salt Lake City, Utah (12-14-23) ..... 9..R. E. Stephenson
Valparaiso University, Valparaiso, Ind. (11-26-58) ..... 5..E. E. Weston
Vanderbilt University, Nashville, Tenn. (1-28-43) .....13..J. R. Wilson
*Vermont, University of, Burlington, Vt. (4-6-28)12..C. W. Hoilman
*Villanova University, Villanova, Pa. (10-20-33) . 2..R. D. Avil
Virginia Military Institute, Lexington, Va. (5-21-20) ..... 4..L. L. Nichols
*Virginia Polytechnic Institute, Blacksburg, Va. (1-8-15) ..... 4..Claudius Lee
*Virginia, University of, Charlottesville, Va. (2-9-12) ..... 4..J. M. Roberts
*Washington, State College of, Pullman, Wash. (12-13-07) ..... 9..M. Liu
*Washington, University of, Seattle, Wash. (12-13-12) ..... 9..F. D. Robbins
*Washington University, St. Louis, Mo. (2-5-04) 7..M. J. Fisher
*Wayne University, Detroit, Mich. (8-11-47) ..11..R. O. Sather
†West Virginia Institute of Technology, Montgomery, W. Va. (5-28-57) .....14..P. M. Gray
*West Virginia University, Morgantown, W. Va.14..E. C. Dubbe
†Wichita, University of, Wichita, Kans. (5-28-57) ..... 7..Martin Bradshaw
*Wisconsin, University of, Madison, Wis. (12-12-19) ..... 5..W. B. Swift
*Worcester Polytechnic Institute, Worcester, Mass. (10-14-25) .....12..W. R. Grogan
*Wyoming, University of, Laramie, Wyo. (10-14-25) ..... 6..R. K. Beach
*Yale University, New Haven, Conn. (10-13-11) .12..J. C. May
*Youngstown College, Youngstown, Ohio (4-14-55) .....14..E. A. Klingshirn

Total Branches 164

*Joint AIEE-IRE Branches 118
†Affiliate Branches 18

208 American Bridge Towers with spans up to 3,345′

carry Kentucky Utilities' new 138-kv line through rugged mountains

Kentucky Utilities Company, a customer since 1918, recently bought 208 more American Bridge towers for its new Richmond-Lynch 138-kv line. Running through rugged mountainous area, these towers vary from 60 to 75 feet in height. *The longest span is 3,345 feet.*

The single-circuit line is made up of three 556 MCM A.C.S.R. conductors and two 7/16″ steel overhead ground wires. The weight of each tower is about six tons, making a total weight along the entire line of nearly 1,300 tons. USS MAN-TEN steel was utilized in these towers at critical points where greater strength was required.

If you are unfamiliar with American Bridge tower service, an inquiry will bring detailed information. We have the experience, the engineering know-how, and the fabricating facilities to design and build any type of steel tower to meet your requirements.

USS and MAN-TEN are registered trademarks

American Bridge Division of USS United States Steel

General Offices: 525 William Penn Place, Pittsburgh, Pa. Contracting Offices in: Ambridge · Atlanta · Baltimore · Birmingham · Boston · Chicago Cincinnati · Cleveland · Dallas · Denver · Detroit · Elmira · Gary · Harrisburg, Pa. · Houston · Los Angeles · Memphis · Minneapolis · New York · Orange, Texas · Philadelphia · Pittsburgh · Portland, Ore. · Roanoke · St. Louis · San Francisco · Trenton · United States Steel Export Company, New York

New and Improved Products . . .

Light Dependent Resistor . . .

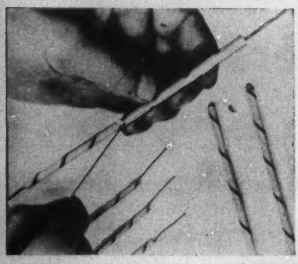
This small-sized light dependent resistor is ideally suited for automatic control of television picture brightness and other applications calling for a change of circuit resistance as light intensity varies. Consisting of a cadmium sulfide cell with silver electrodes, the resistor has a resistance ratio in excess of 25,000 to 1 for a light intensity from total darkness to 1,400 foot-candles. Advantages are low cost, long service life, and elimination of high gain amplification stages. **Ferroxcube Corporation of America, Saugerties, N. Y.**

250-Ampere Silicon Rectifier . . .

Low thermal drop and low junction temperature rise are built-in features in this Y series rectifier rated at 250 amperes d-c. This combination minimizes thermal-aging problems and extends life expectancy. Ideally designed for use in welding, electroplating, and electrolysis, this series is also useful in any application requiring 1,000 or more d-c amperes. **Sarkes Tarzian, Inc., Rectifier Division, 415 N. College Ave., Bloomington, Ind.**

Peelable Ceramic Insulation Beads . . .

Articulated ceramic insulating beads in paper tubes that peel away after stringing, allow 6 to 12 inches of wire to be bead-insulated in one second. This is accomplished by stringing the full tube length of beads on the wire and then pulling a string that splits and removes the



paper tube. As high as 75% assembling time can be saved by using this method. **I. D. Saxonburg Ceramics, Inc., Saxonburg, Pa.**

Electronic Controlled Transformer . . .

An electronically controlled self-regulating distribution transformer supplements the hydraulically controlled units currently undergoing field testing. The principal difference is that the electronic unit has a sensing device consisting of encapsulated, miniaturized, solid-state electronic components housed in a metal container. A convenient plug and receptacle permits external mounting of the control on the transformer. The sensing unit is factory calibrated for a midpoint setting in the range from 120 through 126 volts. **Line Material Industries, McGraw-Edison Co., Milwaukee 1, Wis.**

Solar Cell Gas Detector . . .

A new concept in detection to guard motorboats and yachts from gasoline fume explosions employs a platinum filament which emits infrared rays when fumes are present. A silicon solar cell senses the infrared energy, converts it into a small electric current which is then amplified by a transistor to trigger a flashing red light on the boat's instrument panel. As a reminder, just one cupful of gasoline, when vaporized in the unventilated air of the bilge or engine compartment, can be as lethal as 5 pounds of dynamite. **Raytheon Co., Waltham 54, Mass.**

Portable Cyclic Tester . . .

Hundreds of standard cyclic tests for electric and electromechanical apparatus can be performed with this instrument. Weighing only 22 pounds, it can be moved conveniently to perform a wide variety of repetitive test functions, such as life, duty cycle, temperature rise, or load testing. It can be used for checking out motors, relays, transistors, vacuum tubes, solenoids, transformers, and other electrical components. An over-ride control permits either automatic start or shutdown of test from a remote control device such as counter, limit switch, or temperature signal. **Automatic Timing & Controls, King of Prussia, Pa.**

Miniature Radiation Meter . . .

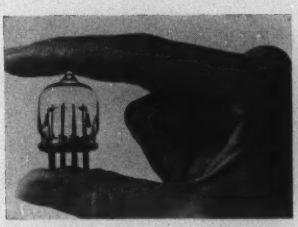
This gamma dose rate meter, used to monitor radiation levels for personnel safety, is small enough to carry in the pocket. Three models provide a selection of wide roentgen-per-hour logarithmic responses without range switching. Accuracy is $\pm 30\%$ of any dose rate on the scale. More than 30,000 readings can be made with one set of batteries. **Jordan Electronics, a Division of Victoreen Instrument Co., 3025 W. Mission Rd., Alhambra, Calif.**

Microminiature Circuits . . .

A special research program has developed a microminiature binary flip-flop circuit so small it can be hidden under a five-cent coin. The unit contains 15 electronic components including transistors, capacitors, diodes, and resistors mounted on a ceramic base. The first circuit was built completely by hand with the aid of a microscope. Since then, a micromanipulator has been introduced to aid a precision positioning of the minute components. **Melpar, Inc., A Subsidiary of Westinghouse Air Brake Co., Falls Church, Va.**

Sun Bright Flash Tube. . .

Called the FX-6A, this xenon-charged glass tube is $\frac{7}{8}$-inch in length and diameter yet has a peak light output of 3,500



horizontal candlepower at a flash duration of about 3 microseconds. Under maximum power input the tube is reported to have a half-light output expectancy of at least 20 million flashes. By derating input conditions, a 100-million flash life can be attained. A compact, transistorized driver circuit enables operation from a conventional dry battery source. Applications include stroboscopic studies, analog digital readout, shaft position encoder, cold cathode switch tube, microfilm recorder, and as a constant reference light source. **Edgerton, Germeshausen & Grier, Inc., 160 Brookline Ave., Boston, Mass.**

Sinusoidal Constant Voltage Transformer . . .

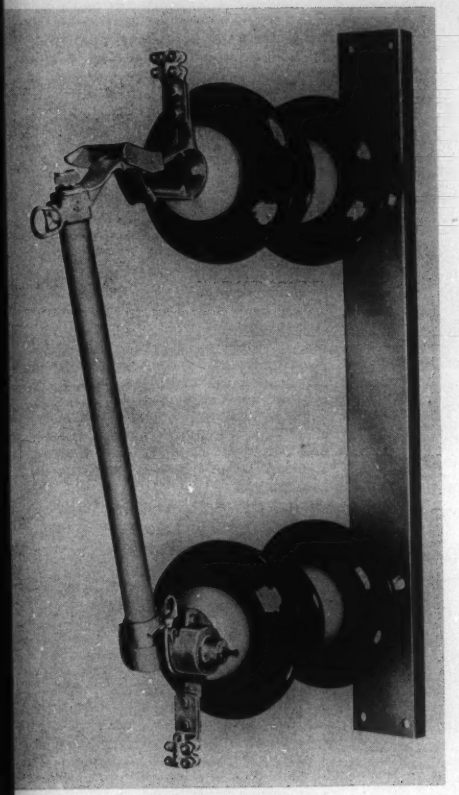
A major advance in the development of static-magnetic voltage regulation provides sinusoidal output and $\pm 1\%$ stabilized voltage for line variations of $\pm 15\%$ for the price of voltage regulation alone. Not only will this result in wider applications of the unit, but it will also simplify selection when ordering. This new line, which has no tubes or moving parts and requires no maintenance, is available in nine ratings from 60 to 7,500 volt-amperes. **Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.**

Snooperscope for Plant Security . . .

Developed for U. S. Navy signaling and reconnaissance in complete darkness, the Snooperscope is used by plant guards for after-dark surveillance. In addition, it has industrial applications in film processing inspection, chromatography, and in observing the infrared luminescence of minerals. With a change of lens it can be used for infrared microscope and telescope work. A self-contained power source converts the output of two flashlight batteries to 4,000 volts. The objective, an f/0.9 Schmidt lens system in conjunction with the image tube, converts the invisible infrared to visible light. **Edmund Scientific Co., Barrington, N. J.**

(Continued on page 22A)

Power Fuses by Southern States



TYPE HP

7.5 kv to 69 kv—300 and 400 amps

This extra heavy duty fuse is especially suited for applications requiring a combination of high continuous current and interrupting ratings.

COMPLETE FUSE KITS AVAILABLE

These economical kits, in clearly marked packages, provide field personnel with *all the components necessary* for quick, easy re-fusing. They are available in four speed ratios to meet all requirements. Contents are sealed in moisture-free polyethylene bags.

- **HIGHEST INTERRUPTING RATINGS**
  Up to 785,000 kva at 23 kv—
  2,350,000 at 69 kv—3,480,000 at 161 kv
- **LOWEST INITIAL AND RE-FUSING COSTS**
- **WIDEST RANGE OF SELECTIONS**

Here is the greatest development in power fuses in years! It comes at a time when higher system faults and complex load conditions call for greater reliability in system protective devices.

Southern States Power Fuses can be used with full assurance of positive interruption in the complete range of fault currents—from the lowest that will melt the current-responsive element to the worst jolt the system can deliver!

The fuses employ a new fuse holder design and rugged fibreglass* fuse tubes to clear faults at values never before thought possible.

For example, look at these representative ratings:

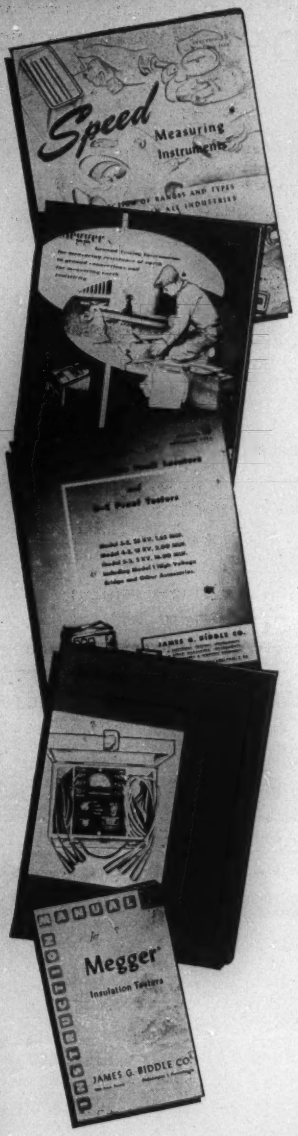
TYPE	KV	KVA 3 phase symmetrical
BP	7.5	162,000
BP	15	406,000
BP	23	785,000
BP	34.5	1,175,000
MP	46	1,988,000
MP	69	2,350,000
MP	115	3,110,000
MP	138	2,980,000
MP	161	3,480,000

Find out how these new Southern States Power Fuses can be used on your system—to provide greater protection at lower cost. See your Southern States representative, or

WRITE FOR NEW TECHNICAL BULLETIN 59PF

SOUTHERN STATES EQUIPMENT CORP.
HAMPTON, GEORGIA

**For economy and where duty requirements are not excessively high, fuse tubes of NEMA grade XX bakelite are available below 46 kv at lower prices.*



PRACTICAL HELP FOR MEN CONCERNED WITH ELECTRICAL MAINTENANCE

Biddle literature and Biddle Instruments are the universally accepted tools for preventive maintenance programs—they are integral parts of electrical operations everywhere.

Many thousands of copies of the manuals and technical publications, prepared by our engineering staff, are supplied annually to men in industry. In-plant training programs, engineering and trade schools include these down-to-earth discussions of electrical resistance and speed measuring techniques in their courses.

No File Complete Without These Useful Publications

If you are concerned with the maintenance of important electrical equipment, your files should include practical, dependable information on these subjects:

Insulation Resistance Testing — **Manual 21-JEE**

Earth Resistance Testing — **Bulletin 25 EE**

Motor & Phase Rotation Testing — **Bulletin 80 EE**

Cable Fault Locating — **Bulletin 65 EE**

Speed Measuring — **Bulletin 35 EE**

Simply list on your company letterhead any or all of these bulletins you would like mailed to you. We will see that you receive regularly Biddle Instrument News.

B-813

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Electrical Testing Instruments • Speed Measuring Instruments
Laboratory & Scientific Equipment
1316 ARCH STREET, PHILADELPHIA 7, PA.

New & Improved Products

(Continued from page 18A)

Transistorized Two-Way Radio . . .

A new line of transistorized two-way radios, in units up to 75 watts, is said to provide the smallest sizes and lowest battery drain commercially available in the mobile communications field. The receiver and power supply are completely transistorized. Only three tubes are used in

the lower wattage transmitting equipment, four in the 30- and 75-watt models. A primary design consideration was lower standby battery drain which has been reduced to 0.040 amperes for the 75-watt model, an amount equivalent to the vehicle's electric clock. **General Electric, Communication Products Department, Lynchburg, Va.**

Total Safety Distribution System . . .

This concept in electrical distribution for industrial plants and buildings provides maximum safety in protecting personnel from contact with live busways, motor control centers, switches, switchboards, and plug-in units. Safety slides cover all bus bars and cannot be opened and contact made until plug-in units with their own safety interlock devices are firmly attached to the cover. This method of providing covers, slides, and interlocking controls is applied to all units in the system so that connecting or disconnecting service entrance equipment, plug-in devices, bus centers, switches, and the like can be made in complete safety. **Electric Distribution Products, Inc., 2200 31st St, S. W., Allentown, Pa.**

Oiltight Pressure Switch . . .

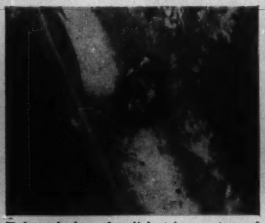
This oiltight pressure switch for heavy duty industrial applications on machine tool hydraulic systems operates at pressures up to 5,000 psi. The **836, Type** *T*, is a compact, attractively styled unit completely sealed to exclude oil and water. A calibrated range scale and indicator shows the operating pressure, and a visible trip indicator shows when the contacts operate. The snap action switch mechanism maintains high contact pressure to the point of the switchover, no matter how slowly it is approached. **Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wis.**

(Continued on page 30A)

We look inside your commutator at National

...The Specialists in electric coils/repair service

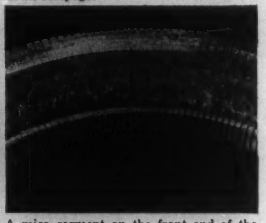
AND HERE'S WHAT WE OFTEN FIND!



Enlarged view of a dielectric puncture of a mica vee ring at the lower end of the copper bar. This is an example of interior commutator faults which may be present though exterior appears excellent.

Shifted or squirted mica at the apex of the 3° and 30° cone surfaces of a mica vee ring. The black lines on the 3°-surface were made by bar-to-bar voltage breakdown creepage.

The bar which projects above those adjacent has been locally overheated under a brush and softened.



A mica segment on the front end of the commutator has started to work out radially and will eventually result in a bar-to-bar short circuit.

When you send D-C machines to National for rewinding or rebuilding, the commutator gets a close inspection and test. But we've found from experience that a commutator that looks excellent on the surface may be in deep trouble inside... with mica cooked, varnish burned, loose copper, or imminent short circuits.

So when we are suspicious of the commutator we remove and open it for a close interior inspection. It's another added assurance that machines rebuilt by National will give you long, dependable service.

For more information, call National's Columbus plant... HUdson 8-1151. Or call the nearest National field engineer.

National Electric Coil

McGRAW EDISON

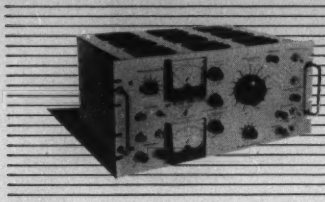
DIVISION OF McGRAW-EDISON COMPANY

COLUMBUS 16, OHIO

ELECTRICAL ENGINEERS • MANUFACTURERS OF ELECTRICAL COILS, INSULATION, LIFTING MAGNETS • REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

NEW IDEAS IN PACKAGED POWER

for lab, production test, test maintenance, or as a component or subsystem in your own products



Series 1000.

Easy-to-use compact Beta Series 1000 high voltage supplies come in 13 different models, providing voltages up to 60kv dc and currents as high as 500 ma. Adjustable output voltage (0 to max. rating with coarse and fine controls); extremely low ripple; easy, rapid polarity reversal and full metering are a few outstanding features.

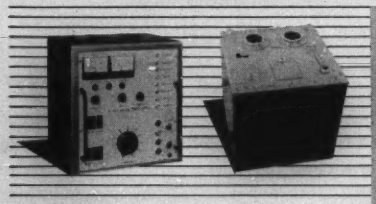
Single-unit, rack-mounting supplies to 60 KV

Available ranges and current capacities:

Output (DC KV)	Current (Max. MA)
0-1	500
0-3	200
0-5	10 or 100
0-10	2, 10, or 50
0-15	5, or 10
0-30	2, 5, or 10
0-60	5 @ 50 KV 1 @ 60 KV

Inputs: 117 vac, 60 cps, single phase

HV DC TO 250KV WITH MAXIMUM CONVENIENCE, SAFETY



Series 2000 — control section (left).
Series 2000 — high-voltage section (right).

Simple to operate, conservatively rated to insure long, optimum performance with maximum safety, Beta Series 2000 supplies come in thirteen different models, with maximum voltages ranging from 1 to 250kv dc. Output voltage continuously adjustable from 0 to maximum. Two-unit design allows optional remote operation of high voltage circuits. For maximum voltages less than 30 kv, the high-voltage unit is air-insulated; for higher voltages, oil-insulated (shipped dry). Every precaution is taken to insure personnel and equipment safety.

Two section supplies to 250KV

Available ratings:

Output (KV DC)	Current (Max. MA continuous)
0-1	3000
0-3	1000
0-6	500
0-10	200
0-20	150
0-30	30
0-30	100
0-50	10, 50
0-120	5
0-120	25
0-150	5
0-250	10

Inputs: 117 vac, 60 cps, single phase

Sorensen markets the widest line of controlled power equipment available today, including: Regulated a-c and d-c supplies, unregulated power supplies, frequency changers, inverters, and converters, SAMES electrostatic generators for regulated voltages up to 600 kv dc, voltage reference sources, high-voltage d-c overpotential testers and high-potential test equipment.

An exceptionally wide selection of standard models is available and experienced Sorensen engineers are always glad to discuss your special needs. 9.13

Sorensen

SORENSEN & COMPANY, INC.

Richards Avenue, South Norwalk, Connecticut

WIDEST LINE OF CONTROLLED-POWER EQUIPMENT FOR RESEARCH AND INDUSTRY

IN EUROPE, contact Sorensen-Ardag, Zurich, Switzerland. **IN WESTERN CANADA,** ARVA. **IN EASTERN CANADA,** Bayly Engineering, Ltd. **IN MEXICO,** Electro Labs, S. A., Mexico City.

New & Improved Products

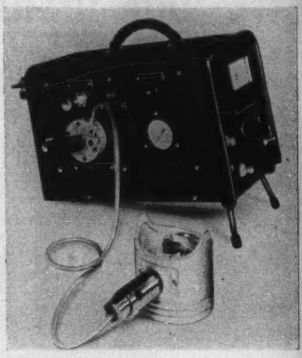
(Continued from page 22A)

Electrical Shielding Tape . . .

Intercommunications wire "crosstalk," a nuisance under any circumstances and a hazard in aircraft, now can be virtually eliminated through use of a new electrical shielding tape called Metalshield. Not only is this material more effective than braided copper wire in preventing inductance, but it is also 50% smaller, roughly 34% lighter, and substantially easier to apply. Metalshield is produced by laminating 0.00035-inch aluminum foil to 0.0005-inch Mylar and then slitting it to desired widths. **The Dobeckmun Co., 3301 Monroe Ave., Cleveland 1, Ohio.**

Limit Signaling Comparator . . .

Ideal for small lot inspections or spot checking of production runs, this instrument allows direct readings ranging from 0.00005 inch to 0.001 inch per dimension using one of nine different gauge heads. The gauge head is first adjusted by means

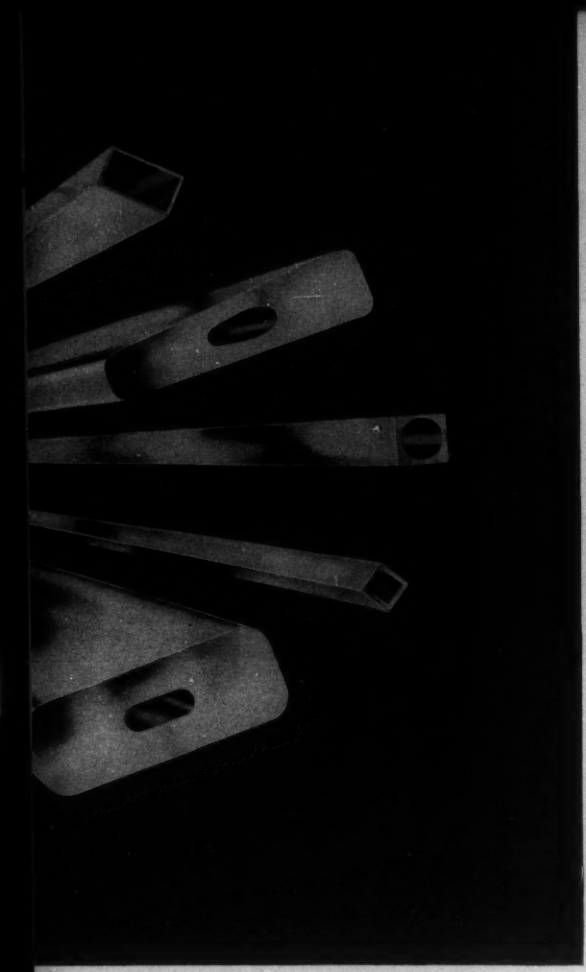


of the vernier until the reference part size is indicated on the meter. Then with the set-up switch in proper position, the desired limits are dialed in and the coarse and fine signal controls are adjusted. **Radio Corporation of America, Industrial and Automation Division, 12605 Arnold Ave., Detroit, Mich.**

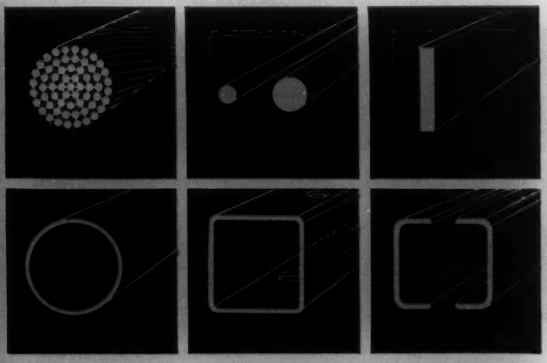
Silicone Cable Insulation. . .

This silicone rubber compound requires no mill freshening prior to extrusion and is ready for direct feeding from the shipping container into the extruder. Identified as *1601*, the material has been designed for faster extrusion rates and dense, homogeneous insulating walls without postcuring. The material maintains its electrical properties at high temperature and remains flexible over wide temperature ranges. **Dow Corning Corp., Midland, Mich.**

(Continued on page 36A)



ELECTRICAL COPPER



Standard Anaconda copper bus conductor shapes.

200,000 KW AT 750 VOLTS is maximum peak rating of twelve d- generators providing power for the confining field coils i C Stellarator being built in the new fusion research facility a Princeton University. This power is needed to establish the max mum 50,000-gauss magnetic field, forming the walls around th reaction aimed at reaching 100 million degrees. A.E.C. demor stration model above shows one form of the Stellarator tube tha has been considered. The big copper bus (top), 9 square inche in section and silver plated, will carry the tremendous power fro the generators to the coils around the Stellarator tube. Th American Brass Company has furnished the mile of bus require for the job to specifications of the Allis-Chalmers Manufacturin Co., Milwaukee, Wisc., which is assisting in the design an building of the C Stellarator.

ANACONDA®

ELECTRICAL COPPER PRODUCTS

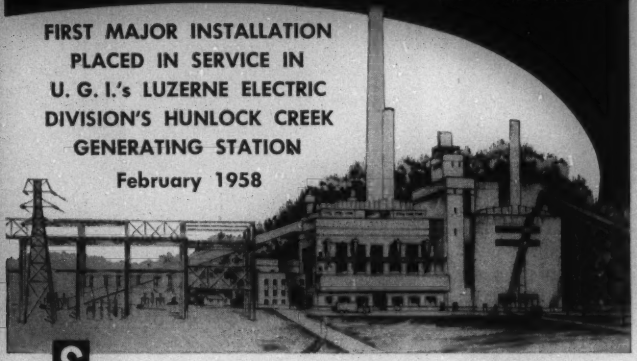
Made by The American Brass Company

*GTC PROVED RELIABILITY

IN-PLANT COMMUNICATION SYSTEM

FIRST MAJOR INSTALLATION PLACED IN SERVICE IN U. G. I.'s LUZERNE ELECTRIC DIVISION'S HUNLOCK CREEK GENERATING STATION

February 1958



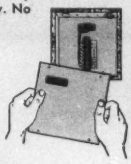
Since that time, the GTC system delivered constant, uninterrupted service. New plant unit will include extension.

This installation, as well as thousands of GTC units that have been installed in power stations and industrial plants throughout the United States since, have definitely established the superiority and reliability of GTC in industrial voice communications.

Features contributing to GTC's acceptance and reliability are:

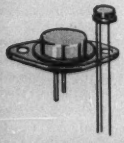
1. Provides swift and sure voice communication even in adverse environmental conditions, such as extremes of temperature and noise.

2. All amplifiers are "plug-in" contributing greatly to ease of installation and maintainability. No central equipment is required.



3. Long-life transistors and rugged, industrial type components are used throughout. No vacuum tubes or "entertainment" type components are employed.

4. Inconvenience and expense of vacuum tube replacement is eliminated.



5. Design allows expansion of system from "very small" to "very large" by simple addition of units where required.

6. Ultra simple wiring plan (no shielded cables) and unitized equipment with integral terminal facilities make for easy low cost installation.

*Gai-Tronics Transistorized Communications is an effective, economical industrial communication system designed to provide swift and sure voice communications regardless of distance or surrounding noise conditions.

GAI-TRONICS
CORPORATION
Dept. B
READING, PENNA.
A SUBSIDIARY OF GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS

GTC is extremely flexible in application. Write today for a copy of our completely illustrated descriptive booklet and name of nearest representative.

New & Improved Products

(Continued from page 30A)

Light Control Acts Like a Thermostat . . .

A light control system that measures daylight in a room and balances it with the correct amount of electric light to assure a constant level of illumination will eliminate uncomfortable glare and produce up to 50% savings in power costs. A photoelectric scanner is mounted where it can best monitor the amount of combined daylight and artificial light in a room. This information is then relayed to a signal station which compares the reading to the dialed light setting. If the readings differ, signals are sent to the automatic light controller which dims or brightens the lights to maintain the desired level. **The Superior Electric Co., Bristol, Conn.**

Antistatic Spray . . .

When sprayed on paper, textiles, rubber, leather, glass, or plastics, this nongreasy, nontoxic aerosol spray, which dries in an instant, will prevent attraction of dust, shocks, or clinging due to electrostatic formation. It is useful for spraying feedboards, cylinders, packing sheets, and tympans of printing presses, and for the drive belts, tapes, aprons, and rollers of all types of machinery. **The Simco Co., 920 Walnut St., Lansdale, Pa.**

Commswitch . . .

This electronic device assures uninterrupted voice communication over telephone lines by sensing signal distortion and then switching the conversation automatically to a second line. An incoming voice signal enters the first Commswitch from the transmitting set and is split into two paths, one signal going to the receiving set, the other for use as a test sample. If the degradation exceeds a value selected in a sensitivity control in the second Commswitch where the signal is being received, a logic circuit indicates primary line trouble. A switchover to an alternate line then occurs and an alarm is sounded. **International Telephone and Telegraph Corp., 67 Broad St., New York 4, N. Y.**

Grinding and Seasoning Machine for Large Commutators . . .

The difficult operation of grinding and seasoning the commutators of large electric motors and generators has been simplified by this machine, designed initially for refinishing the armatures of diesel-electric locomotives. The machine will handle many different types of motor and generator rotors between 20 inches and 48 inches in diameter, weighing up to 9,000 pounds. A unique work-positioning system, in which the armature shaft-end rests in a two-piece roller mounting, reduces set-up time to less than 30 minutes. **Pathex (Canada) Ltd., 107 Tycos Dr., Toronto, Canada.**

(Continued on page 40A)

SUBMARINE SIGNAL

Newport, Rhode Island
W. Rogers Hamel,
General Manager

Engineering, Marketing, and Production of comprehensive anti-submarine warfare systems. Major products: underwater detection, navigation, communications and fire control equipment.

AIRBORNE ELECTRONIC EQUIPMENT

Maynard, Sudbury, Waltham, Massachusetts
Glenn R. Lord,
General Manager

Engineering, Marketing, and Production of advanced aerospace systems. Major products: navigation, search, and fire control apparatus for manned aircraft, unmanned aircraft, and space vehicles.

SYSTEMS MANAGEMENT

West Newton, Massachusetts
Harold M. Hart,
General Manager

Engineering, Marketing, and Management of major electronic system programs. Activities include systems synthesis, learning machines, weapons studies, microwave supported platform.

HEAVY ELECTRONIC EQUIPMENT

Wayland, North Dighton, Massachusetts
Fritz A. Gross,
General Manager

Engineering, Marketing, and Production of long range surface radars, ordnance and communications sytems. Products encompass 800-ton ground warning systems, missile fire control radars, 96-voice channel pulse code modulation equipment.

SANTA BARBARA

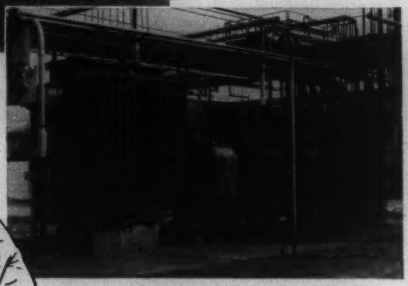
Santa Barbara, Califor
Gordon S. Humphrey,
General Manager

Engineering, Market and Production of inf red and countermeasu devices. Projects invo active and passive EC equipment for aircr missiles, and satelli infrared guidance, m ping, and fire con components.

Right foreground: Nelson Class 1041, oil-immersed, 4160 volt motor starters

Left background: Nelson Class 497, factory-assembled switchrack, 480 volt

Nelson Class 497 switchrack with explosion-proof starters



Nelson 2000 KVA, double front, unit substation (explosion-proof)

Phillips Chemical Doubles Plant Capacity

Editors of a leading magazine recently published a six page article on how Phillips Chemical doubled the production capacity of its Plains Synthetic Rubber Plant. They told how it was done and stressed the importance of selecting quality equipment to assure a high degree of reliability. In addition to the equipment pictured Nelson furnished such vital equipment as motor control centers, explosion-proof circuit breakers, combination starters, control stations and lighting panels.

Nelson takes pride in building quality into every job. If you are looking for a source of electrical control equipment that puts pride of workmanship above all, may we suggest you contact your Nelson Sales Representative. Offices are located in principal cities throughout the United States.

P. S. If you would like a print of the article mentioned please send your request to the factory. It will be mailed promptly.

At Nelson . . . . *quality* comes first!

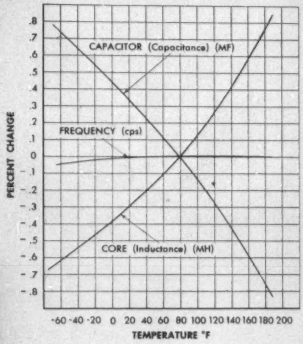
NELSON *Electric* MANUFACTURING CO.
TULSA, OKLAHOMA

New & Improved Products

(Continued from page 36A)

Linear Powder Cores . . .

Used with low-cost polystyrene capacitors, these linear powder cores can achieve extreme frequency stability in filter networks despite wide swings in ambient temperatures and effect considerable cost saving over temperature stabilized cores and



silvered mica capacitors. In the new combination, this is achieved by proper selection of inductors and capacitors so that the net change in one compensates for the net change in the other over the temperature desired. **Magnetics, Inc., Butler, Pa.**

New Insulator Line . . .

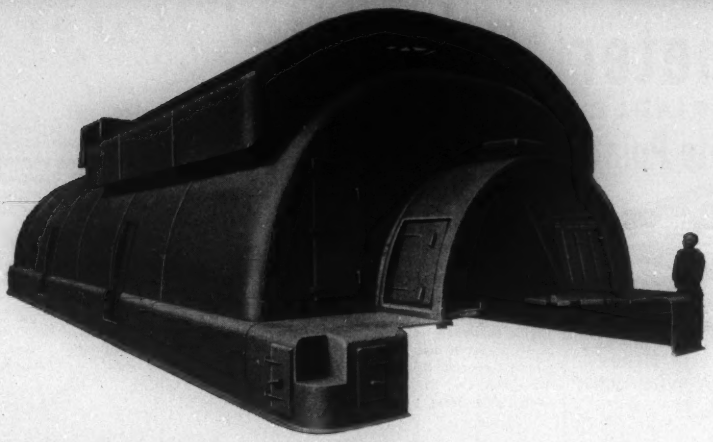
Each of the insulators in this series features an intercepting sleeve designed to protect the porcelain against corrosion stress. As corrosion deposits develop between the sleeve and porcelain, the former gradually yields so that no severe stress is exerted on the porcelain. The Futura insulators have high strength with less weight and no increase in cap diameter over existing designs. **Ohio Brass Co., Mansfield, Ohio.**

Direct-Reading Ohmmeter . . .

Instead of measuring the current flowing through the unknown resistance from a fixed voltage source, this instrument measures the voltage drop produced across the unknown resistor by a constant current, resulting in an accuracy of 0.25% full scale, or 1% absolute. The meter has 11 measuring ranges from 1 ohm to 1 megohm full scale. **Millivac Instruments Division, Cohu Electronics, Inc., Box 997, Schenectady, N. Y.**

Indoor Current Transformer . . .

A new current transformer for low-voltage metering applications by utilities can provide considerable savings where more expensive weather-resistant molded transformers are not required. The type *RT* is designed for 600-volt service in current ratings of 200/5 or 400/5 amperes. **Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa.**



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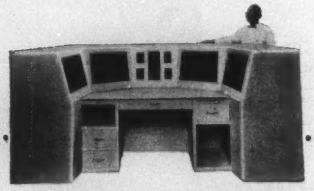
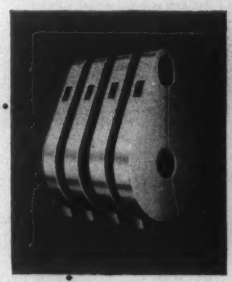
Request your copy of the new 40-page Kirk & Blum Sheet and Plate Fabrication Catalog. Better yet, send us your prints for prompt quotation.





THE KIRK & BLUM MANUFACTURING CO.

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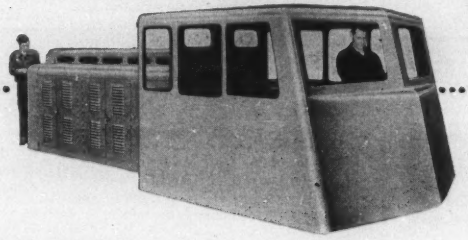
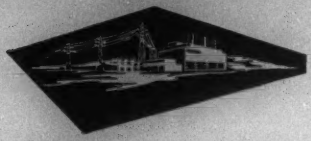
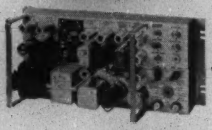


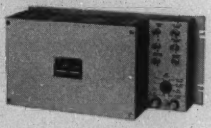
Telemeter
ANY VARIABLE
from Remote Points





MODEL 1025 Transmitter

MODEL 1090 Receiver



Accurate, Fast Acting, Frequency Type Telemeter for Transmission over Wire Lines, Microwave, and Power Line Carrier

Accurate HIGH-SPEED Continuous Telemeter for VOLTS AMPS WATTS VARS ETC.

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Built-in Self-Calibrating Circuit

•

The Model 1025 Telemeter Transmitter converts DC mv from thermal converters, etc., to 10-30 cps which frequency modulates a built-in audio tone channel. AC 10 to 30 cps or relay outputs are also available. Receiver detects and demodulates transmitted signal, generating a DC mv for operation of recorders or indicating instruments. Up to 45 telemeters can be multiplexed.

Any communication link, including power line carrier, microwave or wire line may be used.

Over-all accuracy is 1% with a response speed of 1 second. Equipment features a built-in calibration circuit for 10% and 90% receiver check, and 10 cps and 30 cps transmitter check.

Any quantity which may be converted into a DC millivoltage or will operate a slidewire may be telemetered.

WE CAN HELP YOU
Our Applications Department is ready to assist you in your control, telemetering or communications problem. Phone DEerfield 4-3100.

Write for Technical and Application Data.

Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

Industrial Notes...

Raytheon Co.
Needham Heights, Mass. . .

Circuit-Paks are being used by many well-known electronic equipment manufacturers to simplify equipment assembly, reduce production errors, and increase reliability. These compact assemblies contain semiconductor devices and other components connected to provide the desired circuit. Many different types of Circuit-Paks are available including bridge rectifiers, phase comparators, diode switches, amplifiers, and flip-flops. The final assembly is extremely reliable, compact, lightweight, easy to use, and free from atmospheric effects. Semiconductor Division, Raytheon Co., 215 First Ave., Needham Heights 94, Mass.

Alpha Metals, Inc.
Jersey City, N. J. . .

The partial coating of base metals used as tabs in the manufacture of transistors has been achieved by Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J., semiconductor materials producers, as the result of a new process which enables the company to coat one side of the base metal, to apply a full coating overlay, an edge coating, or a center coating. A second important feature of this process is that it permits the use of a large variety of alloys. The company reports that with equipment developed specially for this process, they can provide stamped, finished pieces with a maximum solder thickness of 0.003 inch.

Branson Ultrasonic Corp.
Stamford, Conn. . .

Union Electric Co., St. Louis, Mo., uses ultrasonic equipment to make meters look and operate almost as good as new. A Sonogen (registered trade mark) generator and tank/transducer, manufactured by Branson Ultrasonic Corp., 40 Brown House Rd., Stamford, Conn., removes even the most stubborn service grime in only a few minutes. And, in reconditioning the instruments, Union Electric avoids complete disassembly, hand-brushing, several rinses, and reassembly. Meter parts, such as threaded line jumper connectors, instrument clock units, and demand registers are racked for easy handling. In addition to meters, Union Electric ultrasonically cleans totalizing relay parts, watches, and instrument frames. The remarkable cleaning ability of an ultrasonically activated liquid is the result of a phenomenon called cavitation, a repeated build-up and release of thousands of voids in the fluid. This action is so powerful that soot, oil, grease, sludge, and even rust are literally blasted off any object suspended in the cleaning medium. Only a faint crackling and the appearance of whitish "spiders" in the liquid give any indication of the tremendous forces being generated.

The Deutsch Co.
Los Angeles, Calif. . .

More than 35,000 square feet of space to be used for a complete production and engineering facility for electrical connectors is being made available in the Deutsch Company's new, air-conditioned electrical connector plant in Banning, Calif. The building will house rubber and plastic molding equipment for connector inserts, a prototype shop, complete design and engineering facilities, a comprehensive certified testing laboratory, complete assembly operation, and the main administration offices of the Electronic Components Division. The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3. Calif.

General Ceramics Corp.
Keasby, N. J. . .

Development of a molymanganese printed circuit called Molumina, capable of withstanding high temperatures and with related greater reliability, has been announced by Advanced Vacuum Products, Inc., Stamford, Conn. The company is a wholly owned subsidiary of General Ceramics Corp., Crows Mill Rd., Keasby, N. J. The circuit is said to operate without deterioration in temperatures exceeding 1,300 F. At present, ordinary printed

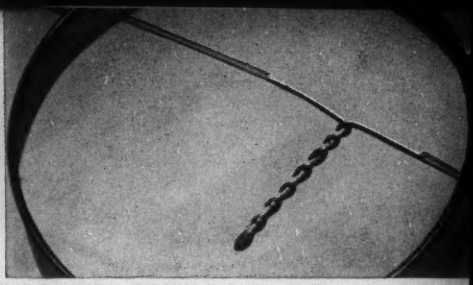
circuits melt or are damaged at temperatures in excess of 400 F. The substrate or base material on which the wiring is printed is made of alumina, a type of ceramic material which is so hard that only a diamond can cut it. An oxide of aluminum, it is a cousin of sapphires and rubies. The Molumina circuits are still in the development stage and the problems of making large units have not been completely solved.

(Continued on page 50A)

JOINT IS COMPLETED WITHOUT STRIPPING WIRE with Analac wire dipped in a 50-50 tin-lead solder at 360°C (680°F). The insulation is removed at the temperature of molten solder.

Analac...

costs for many industries



1. STRONG JOINTS—as strong as the same joints made in bare copper wire—are produced. Here in laboratory test, joint holds under high stress.

2. EXCELLENT ABRASION RESISTANCE of Analac i shown in this test. It has the same high windabilit normally associated with Formvar, Plain Enamel.

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Industrial Notes

(Continued from page 46A)

Radio Corp. of America New York, N. Y. . .

A complete television studio on wheels and a second mobile unit containing tape recording equipment have been provided by the Radio Corp. of America (RCA), 30 Rockefeller Plaza, New York 20, N. Y., to give Termini Video Tape Service of New York City "on location" facilities. The first of the two units houses three RCA cameras with all the allied equipment, a switching system, audio system, and operating space for the production crew members. The cameras are RCA's *TK-31* model, specially designed for field work. While the two mobile units can be employed separately on different assignments, the company plans to use them primarily as a team.

Union Carbide Plastics Co. New York, N. Y. . .

Aerodynamically smooth surfaces required on the supersonic U. S. Air Force *B-58* bomber are made with a calking compound based on Bakelite epoxy resins, a product of Union Carbide Plastics Co., Division of Union Carbide Corp., 420 Lexington Ave., New York 17, N. Y. The *B-58* Hustler, a faster-than-sound bomber, is designed to operate at altitudes over 50,000 feet. The calking formulations based on Bakelite epoxy passed rigid high-temperature tests and resisted swelling of sealing compounds. The calking also withstands in-flight surface friction and temperature with a minimum of cracking. The Metalset *A2* calking compound is manufactured by Smooth-On Mfg. Co., Jersey City, N. J. In constructing the aircraft, spaces between fuselage and wing templates are filled with the material to provide a smooth, continuous surface. The compound is applied with an air-operated gun.

Bendix Computer Division Los Angeles, Calif. . .

The Bendix Computer Division's district sales office serving the San Francisco Bay area and the Northwest, has moved to expanded quarters in downtown Oakland, Calif., at 1330 Broadway, Suite 1121. Sales and service personnel will work from this office under the direction of Harry Doyle.

S&C Electric Co. Chicago, Ill. . .

A new engineering research building is to be built adjacent to the company's Ridge Ave., Chicago, Ill., manufacturing plant. The building, to be completed in 1960, will house all of the company's engineering and research offices and laboratories.

(Continued on page 55A)

SOME ASSIGNMENTS NOW OPEN

Development of nonconventional devices that accurately measure the effects of gear-tooth wear on angular precision; design of gears for miniaturized electromechanical devices; analysis of problems involving the organization and design of high-speed mechanical and electromechanical devices. Experience required in gearing problems arising from information transmission applications.

Theoretical and experimental analysis of dynamic elastic systems; of stability, self-acting, and experimental pressure gauges; of liquid journals and thrust bearings; of solutions to partial differential equations of the elliptical type for various boundary conditions in lubrication problems.

Mechanical movements—study of their addition and communication by fluid-column linkages, and solution of problems in elastic properties of members; investigation of means of storing and handling mechanical "memory" media stored in densely packed bin array.

Thermodynamics problems in aircraft installation and cooling work. Knowledge of heat transfer, packaging, and aircraft structures necessary.

Applied research in noise-generating phenomena in data processing equipment. The work includes analyses of intricate electronic or electromechanical components, measurement of physical effects in noise production, and application of data to the optimization of design parameters for minimum machine-noise output.

Study of the behavior of transient systems, pulse behavior and nonlinear response of mechanical systems; analyses of impact loads on mechanical systems and transducing of energy into and out of mechanical systems.

Research—through photoelasticity—of propagation, reflection and diffraction of stress waves in birefringent materials; study of dynamic stress-optic laws. Experience required in field of applied mechanics or photoelasticity.

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Applied mathematics	Mechanical analysis
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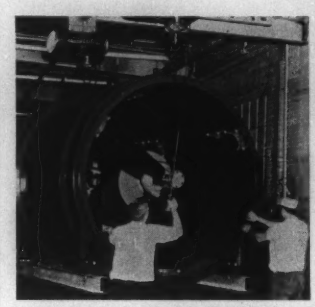
Industrial Notes

(Continued from page 50A)

I-T-E Circuit Breaker Co. Philadelphia, Pa. . .

A high-voltage switch completely enclosed in a section of isolated-phase bus is a space-saving new development of I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa. Designed for use with runs of isolated-phase bus, the unique metal-enclosed high-voltage switch will be a boon to many electric utilities needing to expand in their present crowded metropolitan locations. All of the switching mechanism is contained within the bus housing and telescoping blade action eliminates the need for any extra space for



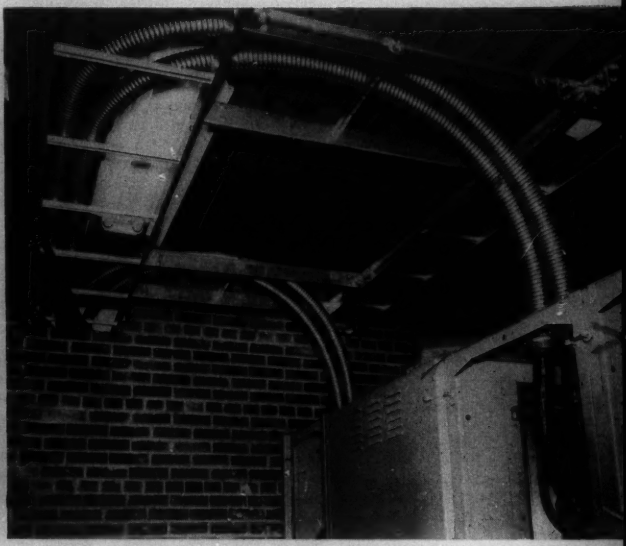
blade storage. Therefore, no additional lengths of bus are required when the switch is added to a standard run. In addition, the completely metal-enclosed equipment guarantees maximum reliability, limits faults to phase-to-ground types, and assures that no live parts are exposed which would constitute a safety hazard to personnel. The ratings for which these switches can be built range in voltage from 69 through 230 kv and in current to 2,000 amp. Switch diameter for any rating would be the same as that of the standard size isolated-phase bus for the voltage carried.

U. S. Testing Co., Inc. Hoboken, N. J. . .

Because of increased activity by various Government agencies in verifying that test equipment calibration meets Bureau of Standards reference standards, United States Testing Co., Inc., 1415 Park Ave., Hoboken, N. J., is now offering a complete service package which will meet Governmental requirements. Included in the service are certificate guaranteeing that test equipment has been compared to standards which can be traced directly to Bureau of Standards references; data sheet log of calibration at various points of the equipment scale; seal attached to equipment, showing date of certified test; and tag attached to equipment, showing date of last test and due date of next test.

(Continued on page 64A)

the right combination for



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   ...*engineering reliability policies.*
   ...*reliability goals for improved weapon systems.*
   ...*reliability objectives for electrical sub-systems.*
   ...*reliability training programs for technical personnel.*
2. *Select, qualify and improve electrical and electronic components.*
3. *Analyze and develop preferred circuits.*
4. *Represent Boeing with customers, vendors and associate contractors.*

If you are interested in the development and in demonstration reliability in weapon systems, you'll find in these openings all the scope you need to develop your career potential to the fullest. You will also enjoy a host of benefits at Boeing, including a retirement plan, paid vacations, insurance programs and an opportunity to participate in company-paid graduate study programs.

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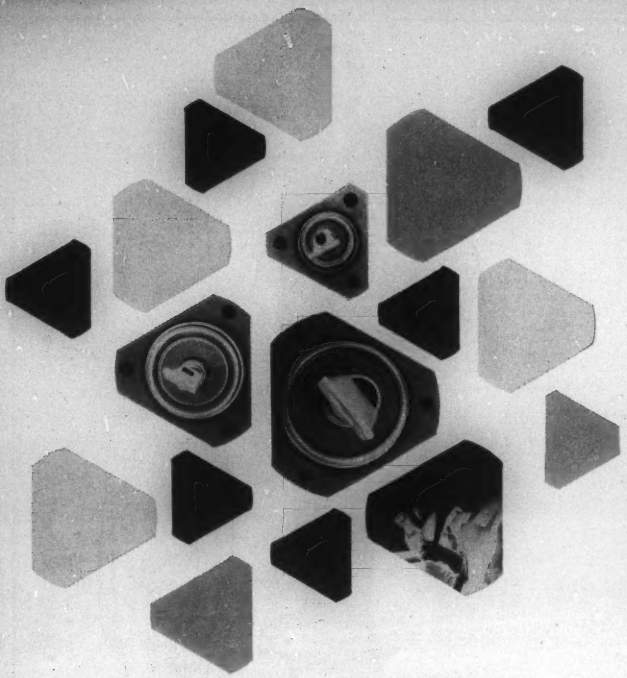

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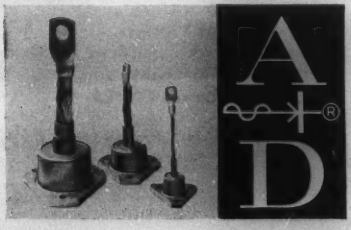
IN CANADA: Alex L. Clark, Ltd., Toronto 18, OVERSEAS EXPORT: ROCKE INTERNATIONAL CORPORATION, New York 16.



Industrial Notes

(Continued from page 55A)

Leeds & Northrup Co. Philadelphia, Pa. . .

A contract for an undisclosed amount from Eastman Kodak Co., Rochester, N. Y., covering infrared equipment for measuring solvent vapors from film roll coating machines, has been received by Leeds & Northrup Co. The equipment includes safety features for alarming and automatically shutting down the machines prior to the time that vapors might tend to reach an unsafe concentration.

Atomics International Canoga Park, Calif. . .

An atomic energy reactor has been shipped by Atomic International to Mayaguez, Puerto Rico, for installation at the Puerto Rico Nuclear Center there. The reactor is a 10-watt, solution-type laboratory reactor, one of six already built by Atomics International, a Division of North American Aviation, P.O. Box 309, Canoga Park, Calif., for educational, medical, industrial, and general research applications, including the production of radioactive isotopes.

Air Reduction Co., Inc. New York, N. Y. . .

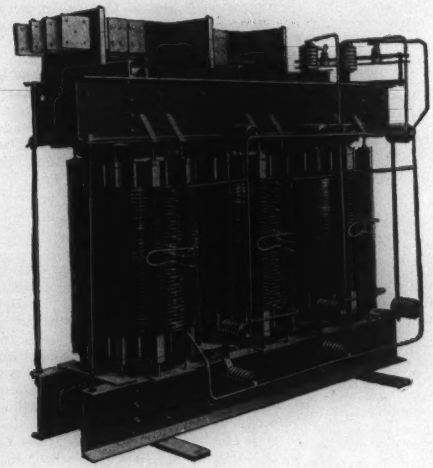
Designed to supplement the facilities of Airco's Central Research Laboratories at Murray Hill, N. J., a new test laboratory in Franklin Township, N. J., will be devoted to research on fuels and oxidizers. The test center will provide facilities for laboratory, prepilot, and pilot scale operations. The Wigton-Abbott Corp., engineers and constructors, Plainfield, N. J., has been awarded the contract for the test laboratory. Air Reduction Co., Inc., 150 E. 42nd St., New York 17, N. Y.

Stromberg-Carlson Rochester, N. Y. . .

The *S-C 5200* electronic printing system prints numbers, letters, or symbols at speeds up to 5,000 lines per minute on preprinted forms. Stromberg-Carlson, Rochester 3, N. Y., sees their widespread use by financial institutions, insurance companies, Government agencies, and manufacturing firms for large volume processing of such business forms as invoices, checks, statements, premium notice, and inventory records. *S-C 5200* systems incorporate several changes from the original *S-C 5000* series to permit printing of preprinted forms with close tolerance. These include an *M-30* storage buffer which stores and interprets data and instructions from digital computers and directs the printing format of the *5200* series. The process combines the use of the Charactron shaped beam tube, a product of Stromberg-Carlson, and a xerographic printing process developed by Haloid XeroX, Inc.

Your plant . . . building . . . equipment depend solely upon the transformer

SORGEL
SOUND-RATED DRY-TYPE
TRANSFORMERS



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Box 620-Q
Douglas Aircraft Company, Inc.
Santa Monica, Calif.

Trade Literature...

Aluminum Welding Book . . .

A comprehensive survey of the techniques of welding aluminum using Air Reduction's Aircomatic (gas-shielded metal-arc) and Heliweld (tungsten-inert-gas) processes entitled "Aircomatic and Heliwelding of Aluminum," (form *ADI 1258*) thoroughly covers the entire subject from a brief historical note on the first uses of these processes for welding aluminum to the highly specialized aluminum fabrications which are being welded with them today. **Air Reduction Sales Co., a Division of Air Reduction Co., Inc., 150 E. 42nd St., New York 17, N. Y.**

Basic Motor Frame Design Brochure . . .

A 4-page brochure on the entire line of basic induction motor frame designs specifies cooled and noncooled designs and offers scaled drawings and mechanical specifications on each design. **Air-Marine Motors, Inc., 369 Bayview Ave., Amityville, N. Y., or 2221 Barry Ave., Los Angeles, Calif.**

Industrial and Motor Controls Catalog . . .

Magnetic contactors, starters, and reversing contactors, together with diagrams of enclosures and dimensions are described and illustrated in a catalog recently released by B/W Controller Corp. Also covered are starter-relay combinations, and combination starters and enclosure. **B/W Controller Corp., 2211 E. Maple Rd., Birmingham, Mich.**

Booklet on Computer Consulting . . .

This booklet describes consulting services available nationally in computers and controls, data processing, guidance systems, and logical design. and includes sections describing specific projects, clients, and key personnel. Copies may be obtained by writing to **Marc Shiowitz and Associates, Inc., 13520 Crenshaw Blvd., Gardena, Calif.**

Reprint on Electrolytic Copper Powder . . .

Production of electrolytic copper powder is described in detail in a technical paper recently prepared by Frank Wills and E. J. Clugston, American Metal Climax, Inc. Reprinted from the Journal of the Electro Chemical Society in booklet form, it covers the step-by-step procedures, equipment, and quality control measures which are required in commercial operations. Included in the booklet are several tables, one of which shows some of the types of powder produced. Copies of the reprint are available from **American Metal Climax, Inc., 61 Broadway, New York 6, N. Y.**

Facts About Plastics . . .

A pocket-sized 4-page booklet compares outstanding properties and typical industrial applications of 13 major plastic families in common industrial use. Included are acrylic, Implex, nylon, Teflon, polyethylene, flexible and rigid vinyl, cellulose acetate, butyrate, polystyrene, high- and medium-impact styrene, phenolic, and fibrous glass reinforced polyesters and epoxies. Five major misconceptions about plastics are corrected. **Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.**

Electric Process Heaters . . .

Catalog *60*, 64 pages long, illustrates the complete line of Chromalox electric process heaters and describes their many uses. This represents over 15,000 types of heaters to fit most heating needs. Also included is a comprehensive application section and a technical section to aid in accurate calculation of heating requirements. Each product is illustrated and described with lists of types, sizes, and ratings. **Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.**

Industrial Coil Catalog . . .

A 44-page general catalog (No. 60) offers detailed specifications and pricing information on 1,300 standard television, radio, and transistor coils, plus an expanded listing of industrial coils and chokes. Included are a separate part-number index and price list; a cross-reference of original parts to Miller equivalents, and 117 i-f–r-f schematic diagrams. Complete new listings on color television items are also included. **J. W. Miller Co., 5917 S. Main St., Los Angeles 3, Calif.**

Literature on Minicast Parts . . .

The story of the new Minicast precision forming process, what it is, what it does, and what type of parts can be so produced, is detailed in a reprint of a feature article made available by Casting Engineers Div., Chicago, Ill. Case studies of eight Minicast parts picture each part, together with an analysis of design problems; how, in some cases, the part was formerly made; what features of Minicast made a changeover desirable; and what benefits are now enjoyed from the new process. Other basic design information covering the Minicast process is also featured. **Casting Engineers Div., 2323 N. Bosworth Ave., Chicago 14, Ill.**

(Continued on page 74A)

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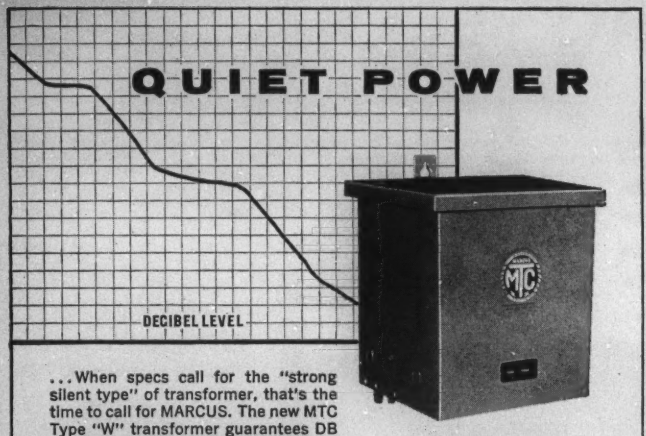

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Publication T-112, totaling 128 pages, consists of 14 papers. Price: $3.50.

Order Department
American Institute of
Electrical Engineers
33 West 39th Street
New York 18, N. Y.

Trade Literature

(Continued from page 66)

Laboratory Apparatus Review . . .

The LaPine Apparatus Review No. 10 features the new line of Freas ovens, incubators, sterilizers, and special purpose cabinets. A Collectochrom (registered trade mark), an apparatus which makes continuous chromatic separations, is one of the new pieces of laboratory equipment introduced in this issue. **Arthur S. LaPine and Co., 6001 S. Knox Ave., Chicago 29, Ill.**

Radioisotopes Bulletin . . .

The fifth in a series of technical bulletins describing uses of radioisotopes in industrial research presents the uses of radioactivity in helping the chemist prove a new method of analysis or extend an established method to a new type of unknown mixture. **Nuclear-Chicago Corp., 229 W. Erie St., Chicago 10, Ill.**

Brakes Bulletin . . .

Bulletin *5000* on d-c magnetic brakes explains in detail the construction features of type *WB* brakes, which are available in six sizes to cover the complete range of *600*-series motors. Maintenance procedures and selection charts for matching brakes to specific motors are also illustrated. **The Electric Controller & Mfg. Co., Division of Square D Co., 4500 Lee Rd., Cleveland 28, Ohio.**

Bulletin on Floating Floor . . .

An illustrated bulletin with photographs of actual installations of floating floors in computer and data processing rooms is designed to show quickly and graphically the chief features of the floating floor and how various companies are using it for infinite access to subfloor areas. Features of the floor that are illustrated include the interchangeability of floor plates, the ease with which floor plates can be lifted out, installation of cutouts for cables, and use of the floor as a pressurized plenum. **Floating Floors, Inc., 22 E. 42nd St., New York 17, N. Y.**

Elgiloy Handbook . . .

A 26-page handbook gives full technical facts on Elgiloy, an alloy that would insure the utmost dependability and trouble-free performance in applications requiring a spring. Described are the unique properties of Elgiloy. Among the facts listed are the alloy's extremely high resistance to corrosion, high resistance to set and fatigue, and its nonmagnetic quality which makes it ideal for instrument applications. Elgiloy offers greater spring power with decreased spring size and will maintain its spring characteristics up to 1,000 F. **Abrasives Division, Elgin National Watch Co., Elgin, Ill.**

(Continued on page 82A)

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC.

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These items are listings of the Engineering Societies Personnel Service, Inc. This Service, which cooperates with the national societies of Civil, Electrical, Mechanical, Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members and non-members, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 5% of the first year's salary if a non-member, or 4% if a member.

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Men Available

SUPERINTENDENT OPERATION AND FOR MAINTENANCE, Small Utility or Industrial Plant; 53. 30 years' experience-maintenance and operations; small diesel powered generating plants and industrial plants. Responsibilities included design, procurement and construction—power units, switchgear and distribution systems also instrumentations in both USA and foreign countries. Location desired: Middle Atlantic and Southern States. E-148.

APPLICATION ENGINEER, B.E.E., 33. Nine years' experience in application design engineering of custom test, control, and low voltage distribution panels. Design of panels to meet customer requirements. Location desired: East or Midwest. E-975-Chicago.

DESIGN—ELECTRICAL CONTROL EQUIPMENT: Age 35. Six and one-half years' senior design, develop, test circuit breakers, switchgear; manufacturers. One year manager, charge engineering operations; manufacturer electrical line hardware, substations, fusegear. Three years' director and chief engineer manufacturing moulded case circuit breakers and small controls. $11,000. Prefers California, or any. Home: California. S(M)-1354

OPERATING SUPERINTENDENT—ELECTRIC UTILITY: EE, age 43. Eleven years' operating superintendent, electrical system; utility. Four years' relay and control application; utility. Four years' general system voltage regulation; 1 year steam plant operation, test. Four years' part-time instructor, circuits, machinery, radio, electronics. $15,000. Prefers West Coast, Ohio, Penn. Home: S(M)-1401

DESIGNER—ELECTRIC CONTROL EQUIPMENT, INSTRUMENTS: EE, ME (France). Age 52. Four years' design electric circuits, controls, calculations; electric and mechanical precipitators manufacturer. One year calculations, test; commercial test lab. Sixteen years' supervisor meter and test departments; utility. $600. Prefers California, Foreign. Home: San Francisco. S(M)-1253

RESEARCH, DEVELOP—ELECTRONIC CONTROLS, MOTORS: MS EE, age 30. Three years' research and develop, electronic components, motor controls. Two years' research and develop of electrical motors, design, test. $800. Any location. Home: Wisconsin S(M)-1185

FIELD ENGINEER—ELECTRIC CONSTRUCTION, INDUSTRIAL: EE, Age 40. Five years' field engineer, estimating, progress and cost reports, heavy construction, materials on heavy construction, industrial power, missile test site; electric contractors. Two and one-half years' construction substation, power and light systems. AEC plant. $9000. Prefers West, or any. Home West Virginia. S(M)-1184

SALES, MARKETING—ELECTRONICS, ELECTRIC EQUIPMENT: Physics & Econ. Age 51. One month marketing manager charge operations, advertising, sales promotion; power supplies, electronics. One year buyer; aircrafts. Two years' design, research instrumentation, servo, power handling equipment; wind tunnel test facility. Five years' consultant in electronics. $275 week. Any U. S. location. Home: Los Angeles. S(M)-594

TECHNICIAN, SALES—METALS, ELECTRONICS: Age 25. Two years' technician, forging, swaging, extruding, metallography, studies; research company. Three months' technician; electronic, hi-fi wiring. Four years' technician, electronics, radar, analog computers; Air Force. $600. Prefers: San Francisco East Bay, West. Midwest. Home: Michigan. S(M)-996

PERSONNEL, PROFESSOR—AIRCRAFT, ELECTRONICS, RESEARCH: PhD Ind. Psych. Age 33. Three years' Senior Research Engineer, organize planning, management development; airframe manufacturer. Five years' assistant professor, business, industrial psychology, business administration. One year statistical analyst; government research. $15,000. Prefers West, East Coast. Home: Southern California. S(M)-774

DESIGN, CONSULT—AUTOMATIC MACHINERY, CONTROLS: EE. Age 44. Three years' inventor and consultant, research and development, patents; servo-mechanical machinery, chemical processes; self-employed. Two years' consultant, research, dynamic analyst; guided missiles manufacturer. Two years' administration, research and develop, automatic controls; cameras and instruments. $12,000. Prefers San Francisco Bay Area, San Diego. Home: San Francisco. S(M)-962

RESEARCH, DEVELOP, APPLICATION—ELECTRONIC, MISSILE: EE. Age 27. Three years' head of missile fuse procurement section; Navy (completed). One and one-half years' design, develop new products, electric wiring devices; manufacturer. $650. Prefers San Francisco Bay Area, Northwest. Home: San Francisco. S(M)-933

DESIGN, DEVELOP—TRANSFORMERS: One year Chief Engineer, development, design, manufacturing, develop distribution and small power transformers, new types, reactors, handling special problems; manufacturers. Three and one-half years' design electric power houses, distribution networks, distribution in heavy industry, manufacturing transformers; construction companies. Seven years' transformer engineer, develop new types and high potential equipment; manufacturer. $995 month. Any location. Home: New York. S(M)-600

DESIGN—TRANSFORMERS, ELECTRONICS: EE. Age 29. Three years' design magnetic amplifiers, reactors, motor starters, transformers; manufacturer. $9200. Prefers West, Florida. Home: Wisconsin. S(M)-632

DESIGN, FIELD, MAINTENANCE—POWER PLANTS, AIRCRAFT, TRANSFORMERS: MS EE, ME (Belgium). Age 45. One year tool engineer; aircraft. Three and one-half years' manager, design, estimate, check manufacture of structures, barges, tanks; steel structures. Five and one-half years' power plant, transmission lines installation, maintenance facilities; tin mine. Seven years' design electric equipment, manufacture and test transformers, new machinery, pumps; electric works. $600. Prefers California, or any. Home: Washington. S(M)-611

DESIGN, MAINTENANCE—POWER UTILITY, CONSTRUCTION: EE. Age 40. Fourteen years' supervising design oil processing, electric, steam, water treat plants, details, specifications, supervise operators power plants, air conditioning, utilities; oil fields, refineries. Five years' sales, test, transformers, turbines, switchgear; electric products manufacturer. $1200 month. Prefers Foreign, West, Southwest U.S. Home: Netherlands. S(M)-336

SUPERINTENDENT, MAINTENANCE—ELECTRIC CONSTRUCTION: Genl E. Age 51. Seven and one-half years' electric superintendent, construction and maintenance air base construction; engineers, constructors. Five and one-half years' electric foreman, construction and maintenance; construction companies. $14,000 any location. Home: California. S(M)-305

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DIGITAL COMPUTING LABORATORY SUPERVISOR, degree in physics, mathematics and/or electrical engineering, M.S. preferred, with at least four years' experience in operation of a fairly large-scale digital center. Should be conversant with IBM equipment, routine IBM procedures, have a surface knowledge of programming and programming techniques, etc.; some training in mathematical research, numerical analysis. Should be able to plan and supervise the conduct of research in the numerical analysis. Should be able to plan and supervise the conduct of research in the numerical analysis field. Salary open. Company pays placement fee. Location, Midwest. W7666.

INSTRUCTOR, B.S. in E.E., with at least three years' industrial or teaching experience in basic electricity-electronics courses for high school students. Also applied math and science in above fields. Salary, $8000-$10,000 a year depending on qualifications. Location, Long Island, New York. W7668.

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ENGINEERS. (a) Sales Engineer, mechanical or electrical graduate, with experience in plastic products field, to sell electronic sealing equipment. Salary, $8000-$10,000 a year. Traveling involved. (b) Production Engineer, mechanical or electrical graduate, with at least five years' supervisory production and assembly experience covering industrial electronic equipment. Salary, $10,000-$12,000 a year. Location, New York, N. Y. W7684.

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ENGINEERS. (a) Senior Physicists, Ph.D. in Physics; M.S. in Physics or electrical engineering acceptable. Broad background in applied research in optics, ultrasonics, electro-magnetics, radiation and propagation, CRT and molecular electronics. Extensive experience in laboratory techniques in crystallography. Good theoretical

(Continued on page 88A)

Wiley BOOKS

1. HANDBOOK OF AUTOMATION, COMPUTATION, AND CONTROL
Vol. 2: Computers and Data Processing
Edited by E. M. GRABBE, SIMON RAMO, and DEAN E. WOOLDRIDGE, Thompson Ramo Wooldridge Inc. Full details on design of analog and digital computers and their applications in science, engineering, and business. This is the latest volume in a complete treatment of all aspects of automation and computers giving practical design data for research. design, and development. Vol. 2, 1959. 1096 pages. $17.50. Vol. 1, Control Fundamentals, 1958. 1020 pages. $17.00. Vol. 3, Systems and Components, in press.

2. SOLID STATE MAGNETIC AND DIELECTRIC DEVICES
Edited by HAROLD W. KATZ, General Electric Co., Coherent coverage of dielectric and magnetic properties of the solid state, with magnetization and polarization as a basic electric property. 1959. 542 pages. $13.50

3. ELECTROMECHANICAL ENERGY CONVERSION
By DAVID C. WHITE and HERBERT H. WOODSON, both of M.I.T. Begins with fundamentals of electromechanics, then uses these with selected models to derive the dynamics of typical physical devices. 1959. 646 pages. $12.50

4. PROGRESS IN SEMICONDUCTORS, Volume III
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5. CIRCUIT THEORY OF LINEAR NOISY NETWORKS
By HERMANN A. HAUS ad RICHARD B. ADIER, both of M.I.T. Explores a rational approach to characterizing amplifier spot-noise performance. Technology Press Research Monograph, M.I.T. 1959. 79 pages. $4.50

6. ELECTRONIC CIRCUIT THEORY
Basic Models and Circuits, by HENRY J. ZIMMERMANN and SAMUEL J. MASON, both of M.I.T. Stresses the model concept, with little on specific devices. Uses a generalized theory approach. 1959. 654 pages. $10.75

7. THEORY AND DESIGN OF MAGNETIC AMPLIFIERS
By E. H. FROST-SMITH, Staveley Research Dept. Bedford, England. Covers the whole range, from high-speed to low-level types. Links theory and design to offer a basic understanding of elements of design. 1959. 487 pages. $12.50

8. NONLINEAR PROBLEMS IN RANDOM THEORY
By NORBERT WIENER, M.I.T. The role of biological nonlinear processes in studying self-organizing systems and nonlinear coding processes in communication theory. A Technology Press Research Monograph, M.I.T. 1958. 131 pages. $4.50

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By SUNDARAM SESHU and NORMAN BALABANIAN, both of Syracuse University. A mathematically precise treatment, *unifying* steady state and linear transient analysis, with modern methods, philosophy, and point of view. 1959. 571 pages. $11.75

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SECOND EDITION, by HAROLD F. DODGE, Rutgers University, and HARRY G. ROMIG, Hoffman Electronics Corp. Revised to include over 1700 different "probability-of-acceptance" curves called oc curves. 1959. 224 pages. $8.00

12. SEMICONDUCTOR ABSTRACTS, Vol. IV, 1956 Issue, Battelle Memorial Institute
Edited by E. Paskell, $12.00

13. MOLECULAR SCIENCE AND MOLECULAR ENGINEERING
By Arthur R. von Hippel and others. 1959, $18.50

14. ANALYSIS OF STRAIGHT-LINE DATA
By F. S. Acton. 1959, $9.00

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Trade Literature

(Continued from page 74A)

Pyroceram Progress Report No. 3 . . .

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Digital Computer Brochure . . .

Installations and applications of the Burroughs *205* electronic digital computer system in the petrochemical industry are described in a 14-page brochure. Applications cover exploration and production, and manufacturing and refining, transportation and pipelines, and accounting and marketing. **Burroughs Corp., Electro-Data Division, 460 Sierra Madre Villa, Pasadena, Calif.**

E.S.P.S.
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